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Teachers of Science in
the Catholic High Schools

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With the Editor . . .

It is a source of regret, and of just criticism as well, that Catholic teachers publish so infrequently in the scientific journals. In the past, the reason most commonly given has been that no suitable medium existed for the public expression of their views. That excuse is no longer valid.

Recent numbers of the SCIENCE COUNSELOR show that science teachers in Catholic high schools and colleges have begun to take full advantage of the pages of this journal for the publication of their ideas and experiences. We welcome their contributions. Often we solicit papers when we know that a teacher has special knowledge of a definite field or has been unusually successful in a certain type of work.

But the acquaintanceship of an editor is necessarily limited. There are many teachers in our schools who have important things to say but who are waiting to be invited to say them. They must not be so modest. Each teacher needs the help of every other teacher. Papers on pertinent topics are always welcome from any teacher in any school, no matter how obscure, whenever the articles fit in witn our publication plans.

This journal has never had difficulty in obtaining a plentiful supply of articles. For this we are truly grateful. But we feel that many more contributions, voluntary contributions, should come from those teachers who sincerely desire to advance the cause of science in the Catholic high schools, and who are willing to do something about it.

Are you one of these teachers?

If not, do you know one?

Simple Genetic Experiments

● **By Reverend Edward J. Wenstrup, O.S.B., Ph.D.,** *(University of Pittsburgh)*
DEPARTMENT OF BIOLOGY, ST. VINCENT COLLEGE, LATROBE, PA.

The study of heredity can be either very dull or intensely interesting, depending upon the skill of the teacher in presenting this important topic. Abstract discussions may or may not be understood. Too often they are not. Simple laboratory exercises can be introduced which will arouse interest and insure comprehension.

Contrary to the belief of many teachers, such laboratory work is neither difficult nor costly. Father Wenstrup here explains in detail how it may be done. It was through the suggestion of this progressive teacher that small colonies and less expensive cultures were first made available to small schools by several biological supply houses. Certain of these dealers are to be found among our advertisers.

This timely article should stimulate teachers to vitalize their teaching of heredity.

●

Too many high school teachers, when they get to the chapter on heredity, have their misgivings. They wonder whether they can put the matter across. As a result they are satisfied with passing over the chapter as lightly as possible. This is a mistake, for there is scarcely a topic which is of more interest to the student than heredity.

But, were one to suggest that laboratory work should accompany the chapter, most teachers would cry "Impossible!" To rid teachers in biology of the idea that laboratory experiments in genetics are difficult, this paper is written. Drosophila, as the fruit fly is scientifically called, is readily raised, and a few directions will, I hope, encourage at least one attempt. Most of the equipment is available in the ordinary laboratory, and the little additional that is needed can be obtained cheaply.

The advantages of raising Drosophila are many. More work has been done with this small fly than with any other organism. Many mutations have been discovered. Some are readily seen with a simple hand lens. The food for the fly is easily made, the offspring from a single mated pair are frequently over two hundred, little space is needed to rear the flies, and a generation can be obtained in less than two weeks.

When the flies are kept at 25° C., the time required from egg to adult is about nine to ten days. When kept at room temperature, usually twelve days are needed. As the temperature is lowered, development is retarded still more. In places where heat is turned off at night, it is best to keep the flies in a container with a small electric light burning, but care must be taken that the temperature does not go above 20° C. Higher temperatures are used for experimental purposes, but then abnormalities can be expected.

Food

The simplest food is ripe banana, but it has its disadvantages. Care must be taken that the skin is intact, otherwise stray flies can deposit eggs in the rupture and results will be vitiated. Press about an inch or so of the banana in small vials, 1" x 4", and then add a little dry yeast or a suspension of yeast in water. A small piece of paper toweling may be placed in the vial to absorb excess moisture. Cover the vials with cotton plugs surrounded by coarse cheese cloth, and they are ready for the flies. The great disadvantage with this food is that there is a tendency for the food to drop out of the bottle when the flies are examined, and many of the flies get stuck in the food. This makes counting difficult and it is usually impossible to use these flies for future matings. For this reason other foods which contain agar are frequently used.

Boil 100 cc. of water with 2.5 grams of agar till the agar is completely dissolved. Then add 100 grams of crushed banana, and continue the boiling for a few minutes. Be careful that the banana is not scorched. The hot mixture is put into vials or small bottles, using a funnel. They are corked as described above. When cool, a small pinch of yeast is added. Some workers prefer to sterilize the bottles after the mixture is placed into them to prevent the development of mold, but this precaution is usually not necessary.

Another food extensively used contains the following ingredients:

180 cc. of water, 3 grams of agar, 36 cc. of dark molasses, 24 grams of cornmeal. The agar is dissolved in boiling water and then the molasses and cornmeal are added. The mixture is boiled until it becomes somewhat thick. Then it is put into clean vials or bottles and corked. Yeast is added as above.

Etherizing the Flies

In order that the flies may be examined, it is necessary that they be etherized. A bottle of the same size as the culture bottle is the handiest to use. Fit a cork to the bottle and pin a small wad of cotton to the bottom of the cork. A few drops of ether are added to the cotton and the fumes allowed to disperse throughout the bottle. Drosophila are positively phototropic, that is, they will fly towards the light. Shake the flies down in the culture bottle, and hold the opening away from the light. Quickly remove the cork from the etherizing bottle and apply its mouth to that of the culture bottle. Change the position of the bottles so

(Continued on Page 60)

Biology in Japanese Schools

● **By E. Grace White, Ph.D.,** *(Columbia University)*
DEPARTMENT OF BIOLOGY, WILSON COLLEGE, CHAMBERSBURG, PA.

Instead of studying pickled biological specimens, Japanese children come by bus for a week's stay at a Marine Biological Laboratory conducted by the Imperial University, so that they may collect and examine living specimens. The plan has numerous advantages, and Doctor White believes that it is not impossible of operation in America.

What do you think?

Professor White is the author of the excellent textbook "General Biology" which, since the publication of its second edition in 1937, has been newly adopted by many colleges. This text was reviewed in the December, 1937, issue of the SCIENCE COUNSELOR.

●

A few years ago it was my privilege to spend several months as a guest of the Imperial University of Tokyo in Japan, and while there I became acquainted with an educational policy of the government schools which it seemed to me our American schools would do well to emulate. This was the custom of sending entire classes, and in certain cases, entire schools on excursions to take in the beauty spots of the country and to study nature at first hand.

During the fall months I spent several weeks at the Marine Biological Laboratory which is operated and directed by the Imperial University; so I was able to observe directly the efficient handling of these nature excursions. Every Monday morning I saw a class arrive by bus from some school of high school grade, take up their abode in the dormitory, and settle down for a week of concentrated work at the shore.

The laboratory is situated at Misaki about fifty miles from Tokyo, on the shores of the famous Sagami Sea. It is almost completely surrounded by water but is connected by a narrow strip of land with a little fishing village. The dormitories and professors' homes are on the top of the hill, from one side of which can be seen the Oil Pot Inlet, Aburatsubo, where the water is always calm and never over two fathoms deep, an ideal collecting ground. From the opposite side of the hill one can look far out across the Sagami Sea to the Island of Oshima, thirty miles away. On this island is an active volcano 2,500 feet high.

The working buildings of the laboratory have been erected at the foot of the hill on a curving sandy beach. At the time of my visit in 1930, these consisted of four wooden buildings, a library with research rooms for investigators, a general student laboratory for the visiting classes, an aquarium and motor room, and a two-storied museum. Across the bay from the laboratory can be seen the small fishing village of Misaki from which fishing fleets put out each day in quest of the large sharks from which a set of fins would bring ten American gold dollars from their Chinese neighbors who relish shark fin soup.

From the opposite shore can be seen the picturesque little island, Enoshima, and beyond it in full view the spectacular Mount Fuji, 12,450 feet high, only fifty miles away. No better view of Fuji can be obtained anywhere in Japan, and it presented such different aspects at the various hours of the day that I was tempted to spend many moments sitting on the benches which were provided for this particular view. I liked it best in the evening twilight just after the sun had set behind its cap. In the summer it is a green hill, and since one of the traditions of Japan requires that every Japanese climb Fuji at least once during his lifetime, summer excursions to the top are frequent. During my stay in the fall I saw it change from a green hill to the greatly featured white-capped peak of most pictures and paintings. While the weather at the laboratory was still mild and pleasant, I could see the snow progressing daily a little further down its sides, until by the time I left it had acquired its full adornment.

The situation of the laboratory is unique, however, not so much for its views which strike the foreigner immediately, as for the variety of marine environments available for collecting trips. These are more varied than at any of our American laboratories, because there are two opposing water currents which meet just off its shores, one bringing the fauna from the far north, and the other, the famous Black Current bringing tropical forms from the south. Sometimes the strong west winds blow the tropical plankton directly into the protected inlet at the very shores of the laboratory so that collecting becomes a veritable adventure. For here can be found many of the gigantic and gorgeously colored hydroids, the stalked crinoids and glass sponges which one too often becomes familiar with from bottled museum specimens. Here, too, are found many of the luminous animals, so that collecting after dark offers entertainment. It is thrilling to come upon the luminous jelly fishes from which one can remove the luminous granules with the finger, the luminous squids with their head-lights trailing behind them as the school moves slowly backward, or the smallest shark in existence, the eight-inch luminous black shark. These and many other spectacular finds await the biologist, for the laboratory abounds in good collecting grounds. Here are rocky shores and sandy beaches, mud flats, and tide pools, bottoms of sand and gravel, and bottoms covered with eel grass and coarse shells. There are overhanging ledges and under water

caves, and farther out the deep water regions. The 10 fathom line is only half a mile from the shore, and within three or four miles is the 100 fathom line.

I understand from the director that since my visit in 1930, the laboratory has erected two new concrete buildings, one for the laboratory and aquarium and the other for the museum, so that I have no doubt that European visitors are now comfortably housed. When I visited the laboratory, however, the only beds at the station were in two sparsely furnished bedrooms on the second floor of the wooden museum, and the foot of the stairs which led to them was guarded by an enormous loggerhead turtle on the wall. The only heat provided was a small urn which was filled with live coals of charcoal and placed in the center of the room every evening. Before I left, I was convinced of the wisdom of the Swedish investigator and his wife who were spending a year at the laboratory and who had adopted the Japanese costume in its entirety.

The Japanese kimono coming down over the ankles is a great aid in conserving warmth in a room heated only by a charcoal urn, and the only comfort I found in my museum room was the fact that this was one room where I did not have to remove my shoes before entering. This was a custom I found decidedly chilly in November, and often my amusement in trying to negotiate rice and fish with chopsticks was somewhat marred by the sound of rain outside the dormitory where I knew a pair of shoes was being filled with water while I ate.

These were the inconveniences of a European costume, however, and were not experienced by the groups of students which came in each Monday morning. To them the dormitories offered every comfort, for all the Japanese requires for comfort is four walls, a few quilts for a bed, a cushion for a seat, and a small, square table for his rice and tea. For the girls there is occasionally a mirror also. The students arrived by bus with their microscopes in their hands and made short work of getting established and starting off on a collecting trip. So busy were they that they were seldom seen during the week, although they had many lectures and trips and spent hours in the student laboratory studying the forms they had collected.

Every Friday evening one group left, to be replaced the following Monday morning by a group from a different school. The business-like efficiency of the work, and the ease with which they settled into the life of the laboratory seemed to show a keenness for the acquisition of knowledge which I fear our American students can hardly match. Each week as I watched the groups come and go, I thought how easily some such plan could be initiated in the United States where the summer laboratories are largely unoccupied during the fall and spring months. There seemed to be no difficulty encountered there so far as the rest of the school curriculum was concerned, but taking a full week out of any American school system for the study of one subject only might require a considerable adjustment, and would no doubt present a definite barrier to such a scheme. Nevertheless, it seems to me well worth considering. The value of such a week at the outset of a course in biology can hardly be overestimated. The inspiration would go far toward awakening interest in the subject before the deeper aspects were presented.

Another custom which I found most interesting was that of sending entire schools from all parts of Japan to visit the beauty spots of the country during their most impressive seasons. One of these excursions was taken in the spring during the cherry blossom season, and another in the fall when the maple leaves had attained their full scarlet beauty. It was my good fortune to join with the students in their fall holiday trip to the picturesque town of Nikko, to the north of Tokyo. The train on which I traveled was filled to overflowing with students of all ages and sizes. My friend and I had chosen to travel third class to have a better chance to observe the native customs, and we were greatly amused at the merriment and the continual tea drinking among the travelers. At every stop, and stops were frequent, there was a great deal of bartering through the windows with the vendors of various foods. The favorites were small wooden boxes with rice and eels, and pots of tea. Most of the travelers kept a pot throughout the trip and had it refilled at each station, so that the drinking was almost continuous and the eating only a little less so.

On arriving at Nikko students poured from the train in large numbers and started on foot for Chuzeni. We could see that the streets were already filled with many groups, and although we spent some time getting to a hotel, arranging for a room and a car to make the trip, we found the streets just as full when we started out a couple of hours later. It was impossible to distinguish the instructors except in the groups of small children, but it was possible to distinguish the city groups from the country ones. The city schools for the most part have adopted the European school costume while the country schools still wear the native kimonos. In certain schools, however, it was apparent that some of the students were in European costume and some in native costume.

One interesting thing about the Japanese is his thoroughness, and in no way is this better illustrated than in his school costume. When the Japanese is dressed native he wears the characteristic kimono of flowered material, browns and blues for the boys and reds and yellows for the girls, and when so dressed he wears wooden shoes and never any hat either summer or winter. When he adopts the European costume, however, he dons thick leather shoes and always wears the hat that goes with it. The boy's uniform reminded me of a street-car conductor's uniform. It was dark blue with double rows of brass buttons on the tight fitting jacket, and the cap had a stiff, flat visor. The girls' costume must have been adopted when they were wearing the Peter Tom sailor suits in America. They were also dark blue with sailor blouses over pleated skirts, and

(Continued on Page 58)

The Gardens of the Middle Ages

● **By Sister M. Dafrose, O.P., Ph.D.,** *(Fordham University)*
CHAIRMAN, SCIENCE DEPARTMENT, BISHOP McDONNELL MEMORIAL HIGH SCHOOL, BROOKLYN, N. Y.

It was at the request of the Editor that Sister Dafrose undertook the writing of the paper, the first part of which is here presented. At first, neither Sister Dafrose nor the Editor appreciated the enormous amount of careful research that would have to be done before a satisfactory account of the gardens of the Middle Ages could be written. But in spite of heavy duties and full schedules Sister Dafrose cheerfully began the work and carried it on to successful completion.

You will agree that her pleasant labor was worth while.

The first part of her paper deals with medieval monastery gardens. The second part, which treats of non-monastic gardens, will appear in our September number.

●

PART I

From the day when "God planted a paradise of pleasure . . . wherein He placed man whom He had formed" (*Genesis II, 8*), the cultivation of a garden has been one of the simplest and most gratifying of man's pleasures. Medieval times may be said to extend roughly from 500 A. D. to 1500 A. D.,[1] and during that period of one thousand years many changes in gardening occurred. Gardens inside monastic walls and beyond the castle gates were, at first, very simple, but at the close of the thousand years they developed into elaborate, extensive park-like estates. During the early chaotic centuries of war and strife, the monastic orders kept alive the science of horticulture and spread a knowledge of it among the people. By practicing as well as by preaching, they showed by their useful lives that "to labor was to pray."

Today the word garden carries with it the idea of a place in which flowers are grown for the pleasure which their form, color, and fragrance give to the beholder. In the Middle Ages, however, a garden appeared to have meant not such a complete arrangement as that of a Roman villa, but simply an enclosed space. Typical ideas of an early medieval garden were that it should be a space with an enclosing wall, a fountain, and trees; or a space in which there was a river, a fountain, a pine, a few flowers, and an orchard containing both fruit and forest trees, all enclosed within a wall.[2]

Monastery gardens in most instances preceded castle gardens, and the monks were better skilled in horticulture than any other class of men in the medieval communities. Their way of life tended to maintain this superiority. Monks usually lived peaceful and quiet lives undisturbed by the wars waged in all parts of the country, and although other properties were destroyed and plundered, those of the monks were usually respected. Many of these medieval monks were men of skill and intelligence. They learned both what plants to grow and how to grow them, not only from the books of Aristotle and his favorite pupil, Theophrastus (both of whom laid the foundations of the study of botany and influenced European botanical thought down to the 17th Century), but also from their intercourse with the gardeners of other monasteries.

In the early Middle Ages, gardens were of two types: the *herb* or *kitchen garden* and the *orchard* or *pleasaunce*. The herb garden contained medicinal herbs, aromatic herbs for perfumes, herbs used to flavor dishes (spices) and a few vegetables for family use; as a matter of fact, it was a utilitarian garden. The orchard included both trees and flowers and was largely decorative. However, even the pleasaunce was not maintained for beauty and pleasure alone, since the luxury of gardening merely for pleasure did not appear on the continent, or in England, until the close of the sixteenth century.

The arrangement of the herb garden will be discussed in connection with the herb gardens of monasteries, and of castles. The orchard or pleasaunce will be considered in detail in connection with castle gardens. During the Middle Ages, monastery gardens were cultivated before castle gardens and will, therefore, be studied first.

Medieval Monastery Gardens

Medieval monastic gardening was heir to a long and honorable tradition, for gardening was associated with the life of religious from a very early date. The ascetic hermits of Egypt cultivated vegetable patches, grew trees and raised bees. St. Jerome (4th century A. D.) described the gardens St. Anthony had planted in the deserts, and admonished a young monk: "Hoe your ground, set out cabbages, and convey water to them in conduits."[3] St. Benedict in his Rule made definite provision for cultivating the soil, and work in the fields was a part of the daily horarium of the monastery. The Benedictine Rule stated that "the monastery ought if possible to be so constituted that all things necessary such as water, a mill, a garden and various crafts may be contained within it."[4] The monastery garden preserved the art and technique of horticulture and gardening while the rest of the countryside, harassed by wars was forgetting and neglecting it. In some monastic houses the abbot taught agriculture and husbandry to the farmers in the neighborhood, acting in a capacity similar to that held by the instructor in an agricultural experiment station today. The nuns taught the noble ladies the art of raising flowers and herbs, in fact a "becoming and honourable herbary" grew to be a necessary adjunct to every medieval castle. In

many places the monastery garden carried on strains of fruits and vegetables that otherwise would have been lost. The religious also played no small part in distributing plants, for in going from one monastic house to another or while passing on pilgrimages from shrine to shrine, they interchanged not only horticultural information but also varieties of plants.

The gradual evolution of monastic buildings was conducive to garden making. Those of the western church resembled in structure the Roman villa. They had an atrium in front and a peristyle, or courtyard with a surrounding colonnade, in the rear. This was subsequently renamed a cloister. Usually in the enclosed cloister garden there were central fountains, beds of flowers and herbs and statues of saints. In the East, where the religious dwelt in separate huts or cells each with its small garden, the cells or huts were grouped around a central court. The open pillared court at the west end of Christian churches frequently led to a garden. Sometimes this garden was paved, at other times it was planted with trees and flowers, or, again, it was a burial ground beautifully landscaped. The front courts bore the delightful name of "Paradise"—a sanctuary into which good and bad could flee for rest and safety.

The earliest records of gardens on the Continent (after Roman times) date from the ninth century. In the list of Manors of the Abbey of Saint Germain des Pres, St. Armand and St. Remy in the time of Charlemagne, mention is made of various gardens. At the monastery of Corbie in Picardy the garden was very large, either divided into four parts or else into four distinct gardens. Ploughs which had to be contributed annually by certain tenants were used to keep it in order. Other tenants had to send men from April to October, to assist the monks in weeding and planting.

In the letters written by the poet, Venantius Fortunatus, to his friend, St. Rhadegund, one can learn a few facts concerning the monastic gardens of the period. In the 6th century, this royal lady founded Holy Cross Convent near Poitiers, as a retreat from the dissolute life of the Merovingian Court. Fortunatus, in poetical and friendly words, often returned thanks for the foods of many kinds that Rhadegund sent from the monastery gardens. These foods were usually accompanied by flowers. Once Rhadegund invited him to a feast day dinner at the monastery. "The tablecloth was strewn with roses, the dishes were wreathed with flowers, and garlands were hung on the refectory walls in the fashion of the ancients."[5] Such extravagance in flowers must have meant a large garden and skillful culture.

If flowers were used to decorate the table, they were used in far greater abundance to add to the celebration of religious festivals. Particular little plots in the cloister garden were entrusted to the sacristan, who decorated the church on feast days. The office of a special gardener was mentioned in quite early days, and in the plan of St. Gall, the hortulanus had a house of his own. Sometimes a learned monk took up the work, and according to tradition this was the case at the monastery of Ranshof in Salzburg, down to the time of its dissolution in the year 1811 A. D. At this place the Father Hortulanus had to go around the whole estate once a year, and instruct the peasants in the cultivation of fruits and kitchen gardens. It is not unlikely that the poet who wrote "Meier Helmbrecht," in the 13th century, calling himself "Meinher the Gardener," was one of these men from Ranshof.[6] A pleasing picture—the monks as horticultural teachers of other men, cultivating their own monastic estates and generously sharing with the neighbors their horticultural skill and learning.

St. Isidor of Seville (7th century A. D.), in his Rule for the monks, ordered that there be a garden within the cloister so that "the monks should be able to work there without going outside."[7] The Spanish monasteries were noted for the choice varieties of fruits cultivated in their gardens and this tradition was maintained for many centuries. Fruit was a favorite monastic crop. Apples, pears and cherries were provided for eating. Grapes were raised to make wine. Cider was made in countries where grapes did not thrive. In Italy, Spain, Germany, France, Flanders and England, where monastic houses flourished, the cultivation of vegetables and fruits attained a very high standard.

The most complete plan of a monastic garden in the Middle Ages was that of the Benedictine Abbey of St. Gall, on Lake Constance, reputedly drawn up in the 9th century by Abbot Eginhard, Prefect of the Royal Buildings under Charlemagne. The garden area was divided into four parts—a herb garden, a cloister garth, a vegetable garden, and a combined orchard and burial ground.

The herb garden had 16 straight raised beds divided by a main path with plants around the base of the walls, a patterned garden. The arrangement may have followed the Roman tradition but the raised beds, straight and square, indicated a practical knowledge utilized to facilitate the cultivation of plants. Poets in the later Middle Ages called this arrangement a chess board with pieces moving about. The "herbularis," conveniently placed near the doctor's office, or infirmary, was so located that the sick could look out upon it and enjoy the fragrance of the aromatic odors of the plants. The herbs were plainly marked on the plan: roses, lilies, sage, rosemary, etc.

The cloister garth, or garden, was a rectangular enclosure with a central path leading out from the gardener's house, situated at one end. There were nine long and narrow plant beds, of equal size, on either side of the central path. In addition to the grasses and the shrubs in the plots, the sacristan raised flowers for the altar and to make wreaths or garlands. These were worn by priests on the great feastdays of the church, or were used to decorate the candles and the banners.

The vegetable garden was much larger than the herb garden, and here the "fair plants grew green and tall"[8] as the inscription stated, in eighteen straight

beds, close together. The care of this garden was extremely important for the monks whose diet was vegetarian. Two circular houses north of the kitchen garden were assigned to the poultry, and between the two there was a house for the poultry keeper.

North of the infirmary was the burial place of the religious, a garden "rightly planted with fruit and other trees." In the center was a cross (perhaps a mosaic) in many colors. Between the rows of trees, regularly set out, were the monks' graves. The fifteen kinds of fruit trees indicated seem to have been copied from Charlemagne's Capitulare de Villis without taking into consideration the climate of St. Gall, for it is doubtful whether fig and laurel trees could grow in that climate.

The "Paradise" showed an odd peculiarity of form. It was located on both sides of the church and marked with the word, "Paradise." The spaces were semicircular, and there was nothing to show whether they were meant for gardens or not.

St. Bernard of Clairvaux (12th century A. D.) founded the Cistercians who devoted much time to manual labor. His rule encouraged agriculture and horticulture and his followers worked at gardening many hours each day. That their gardens might be conveniently watered, they frequently located them on rivers and one of the innovations they introduced was to move the well from the center of the cloister garden to the corner nearest the refectory, so that the monks could more readily wash their hands before meals. A contemporary of St. Bernard described the monastery garden thus:

> "The back part of the abbey terminated in a broad plain, no small portion of which a wall occupied which surrounded the abbey with its extended circuit. Within the enclosure of this wall, many and various trees, prolific in various fruits, constituted an orchard resembling a wood. This being near the cells of the sick lightened the infirmities of the brethren with no moderate solace, while it afforded a spacious walking place to those who walked and a sweet place of resting for those who were overheated. The sick man sat upon the green sod, and while the inclemency of Sirius burnt up the earth with his pitiless star and dried up the rivers, the sick man tempered the heat of the glowing stars under the leaves of the trees into security and concealment and shade, from the heat of the day; for the comfort of his pain the various kinds of grass were fragrant to his nostrils; the pleasant verdure of the herbs and trees gratified his eyes and immense delights were present hanging and growing before him so that he might say not without reason: 'I sat under the shade of that tree I had longed for and its fruit was sweet to my throat.' The concert of the colored birds soothed his ear with their soft melody, and for the cure of illness the Divine tenderness provided many consolations, while the air smiled with bright serenity, the earth breathed with fruitfulness and he himself drank in with eyes, ears and nostrils the delights of color, songs and odors.
>
> "Where the orchard terminated the garden began, distributed into separate plots or rather divided by intersecting rivulets, for although the water appeared stagnant, it flowed nevertheless with a slow gliding. Here, also, a beautiful spectacle was exhibited to infirm brethren. While they sat upon the green margin of the huge basin they saw little fishes playing under the water and representing a military encounter by swinging to meet each other. This water served the double duty of supporting the fish and watering the vegetables to which water, Alba, a river of famous name, supplied nourishment by its unwearied winding."[10]

In England, by a careful examination of the records of the various monasteries, the existence of gardens or orchards in the 11th and 12th centuries, and a few of even earlier date, can be found. In fact, a garden was an essential adjunct to a monastery, because vegetables formed so large a proportion of the daily food of the monks.[10]. As soon as monasteries were founded, gardens were laid out around them, and these were possibly almost the only gardens worthy of the name in the kingdom of England at that time. The monks probably received plants from abroad, as connections with religious houses on the Continent were kept up, and, in bringing back treasures for their monasteries, or churches, the garden surely was not forgotten. Plants were chiefly brought for medicine, however, and it may be inferred that they were imported in a dry state, as the word "drug" is simply a part of the Anglo-Saxon verb "drigan," to dry.[11]

In England, as elsewhere in the early Middle Ages, gardens were planted chiefly for their practical use, and vegetables and herbs were grown for eating or for medicinal purposes. Roses, lilies, violets, peonies, poppies, etc.,—all had medicinal uses and their beauty had a wide appeal. A pretty story is told about William Rufus (11th century, A. D.) which portrays that monarch in a more gentle light than do most other incidents of his turbulent reign. Matilda, later the wife of Henry I, was being educated at Romsey where her Aunt Christina was Abbess. When the child was twelve years old, the Red King and his knights appeared at the convent gate and demanded admission. The distressed Abbess made the child wear a nun's veil and then conducted the king into the garden "as if to look at the roses and the flowering herbs."[12] While the rough king inspected the flowers, the nuns passed through the garden, Matilda among them, and the king suffered her to go by and quietly took his leave.

While the Abbess Christina was adorning her cloister garden with roses and flowering herbs, other monasteries were being beautified in the same manner. The first Abbot of Ely, Brithnodus (12th century A. D.) was famed for his skill in planting and grafting and improved the abbey by laying out orchards and gardens.

William of Malmesbury (12th century A.D.) praised the tree garden of Thorney Abbey, near Peterborough, situated in a marshy neighborhood. He described it "level as the sea, the smooth stems of the fruit trees stretching up toward the stars, and luxuriant growths were found everywhere. There was competition between nature and art, and what one failed in, the other produced."[13]

There is a plan of the cloisters at Canterbury, dat-

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The Junior Academy of Science

● **By Reverend P. H. Yancey, S.J., Ph.D.,** *(St. Louis University)*
SPRING HILL COLLEGE, MOBILE, ALABAMA: PRESIDENT, ALABAMA ACADEMY OF SCIENCE

Father Yancey believes that one of the remedies for the dearth of Catholic scientists in the United States lies in the encouraging of high school students to study science. The Editor agrees with him. Active participation in the work of a state junior academy of science has proved to be a valuable means of arousing student interest.

As President of the Alabama Academy of Science—a well-bestowed honor—Father Yancey knows the kindly feeling of the senior academy toward junior groups. As the organizer of junior chapters in Catholic high schools, he appreciates the problems and difficulties that may be encountered in establishing local branches, as well as the benefits that are to be expected from them.

From actual experience, then, comes this helpful paper. You will be impressed by its good common sense.

●

Among the methods of stimulating interest among students in things scientific, one of the best is the science club. Such clubs have been in existence in colleges and high schools for many years and, in some instances, have attained notable results. But merely local clubs often lose their effectiveness. This may be due to various causes, such as the lack of an enthusiastic faculty moderator and the narrow appeal of local programs. These drawbacks have led to the abandonment of once flourishing science clubs in many schools, and have prevented the formation of clubs in many more.

To remedy these defects and to stimulate wider student interest in things scientific, some of the state academies of science have sponsored the organization of junior branches composed of high school science clubs. In the course of time this movement has grown until today in many states there are junior academies of science fostered by the senior academies. The degree of fostering differs with the different academies. Usually, the idea originates with the senior academy. In most cases the senior academy exercises some control over the junior academy through one or more counselors appointed from the former's ranks. In some states the senior academy gives financial assistance to the junior group. The meetings of the two academies are usually held at the same time and place.

The question may arise, what is the purpose of the junior academy of science? The answer to this is twofold. First, there is the point of the utility of a science organization of any kind among high school students. The writer does not believe that this needs justification. Experience has shown the utility of debating clubs, dramatic clubs, etc.; so why not of science clubs? The time devoted to science in the high school curriculum is too short, and the way in which science is sometimes taught is too dry and technical, to gain the interest of young people. Only too often science is looked upon as the bugbear of the high school course. It is something that the student has to "get through," and that is all.

But there are students of an enquiring type of mind, and with a bent for natural science which is poorly satisfied by the ordinary courses. For these there should be provided some outlet for their interest, and for all pupils there should be provided some more attractive approach to science than the textbook and the lecture—that is, if we are going to develop a proportionate number of scientists to meet the ever increasing need for outstanding workers in this field. Such a procedure is also necessary if we are going to develop at least an appreciation of science in all who go through high school so that, on the one hand, they will be sympathetic to the aims of science and learn to pay it the respect it deserves, both in the ordering of their own lives and in the solution of the world's problems, and, on the other, they will know better than to accept blindly everything that is passed off as "science" or to consider it the cure-all for the world's ills.

These are some of the reasons for maintaining science clubs in high schools. But the second part of the answer refers to the *raison d'etre* of the junior academy organization. Some one may object: I can see the reason for having a science club in each high school, but why complicate it with the academy organization? Some of the reasons for this have already been given, but there are others. The first is the same as for the existence of a senior academy. Why should the professional scientists organize themselves into an academy? So that they can benefit by the exchange of ideas with their colleagues in other institutions. Otherwise they become narrow and soon stagnate. Well, the juniors need the same sort of stimulus. In the academy they have to compete with the students of other schools in the presentation of papers and in the exhibition of scientific projects. This competition will make them more active in their studies and stir them to more ingenuity in their project work.

But there is another reason. Through the junior academy they are brought into more or less close contact with the state's leading scientists. They may see them, talk with them familiarly, and be thrilled by their contributions to science. For a day or two they live in an atmosphere of scientific endeavor. This is calculated to inspire some of them to devote themselves to science as a lifework. There can be no doubt, then, that the junior academy idea is a useful one.

Since, however, this discussion is taking place in the pages of *The Science Counselor*, it is pertinent to ask

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Sugar from the Sugar Cane

● **By Paul F. Bailey**
DEPARTMENT OF CHEMISTRY, LOYOLA UNIVERSITY OF THE SOUTH, NEW ORLEANS, LA.

Here is an interesting account of the making of cane sugar, written by one who is located at a strategic point for the obtaining of authentic information.

Mr. Bailey follows the process from the cane fields through to the finished product, showing how sugar is manufactured, refined, and tested. Numerous interesting scientific details are included.

Teachers will find here much valuable instructional material.

Mention of sugar cane is found as early as the fourth century B. C. Its use for several centuries was restricted to chewing the cane and drinking its juice. The earliest positive evidence of sugar in the solid form dates from about 500 A. D. The extraction of sugar from the juice of the cane and the refining of the raw sugar was developed during the 9th and 10th centuries. The exportation of the refined product was an important part of Egypt's commerce during those centuries.

In ancient times sugar was a rare delicacy, highly valued for medicinal purposes. Travelers went on long and perilous journeys just to bring back small amounts of this substance that was then worth many times its weight in gold. Since modern refining methods have placed sugar within the reach of us all, it has become one of mankind's most necessary foods.

Sugar Cane

Sugar cane is a large grass of the genus *Saccharum*. It has long leaves and a stalk which is divided into many joints, and it is this jointed stalk that supplies the juice or sap from which cane sugar is extracted. New varieties of cane have been developed. These are selected for some particular qualities such as richness in sucrose, resistance to disease, etc. The seedlings are designated by initials and numbers, the initials indicating the origin.

Growing and Harvesting the Cane

Sugar cane grows from buds located at the nodes. Cuttings of the cane are planted in rows, with a very shallow covering of soil. The cane, under suitable conditions, is usually planted but once in several years.

In Louisiana, climatic conditions compel the harvesting of the cane after seven or eight months' growth, so that it never fully matures. The season commences in October or November and ends in December or January. When cane is exposed to a temperature below 32° F., and later the temperature rises considerably above the freezing point, a marked decrease in the p^H of the juice is noted. This increase in acidity leads to the hydrolysis of the sucrose in the juice. The production of invert sugar (*d*-dextrose and *l*-fructose) and products of fermentation, represents a loss in crystallizable sugar.

The harvesting of the cane is done "by hand." The Louisiana planter employs the Negro cane-cutter. The workmen, with their broad knives, cut off the stalks close to the ground and top them just above the highest colored joint. The sucrose content of the cane deteriorates rapidly after the stalks have been cut; therefore, these are conveyed to the factory as soon as possible and immediately ground or crushed. The stalks are transported to the factory in mule-drawn carts or small cars. Small narrow-gauge engines, hauling the cars through the fields, are a familiar sight on a Louisiana plantation.

In the extraction of sucrose from the juice of the cane it is well to distinguish two separate plants: the sugar-house or factory, where the raw sugar is made, and the sugar refinery in which plant the raw sugar is refined or purified.

The stages or steps in the two processes are as follows:

1. *In the factory:* (a) Extraction of the juice, (b) Purification of the juice, (c) Evaporation to a sirup, (d) Crystallization of the sugar, (e) Purging the sugar.

2. *In the refinery:* (a) Washing the raw sugar, (b) Defecation of the raw sugar, (c) Char-filtration, (d) Crystallization of the sugar.

RAW SUGAR MANUFACTURE

Extraction of the Juice

At the factory, raking devices pull the stalks from the cars onto endless-chain elevators. These elevators carry the cane to the revolving cane knives or, in other plants, to shredders. The knives, spaced a few inches apart, revolve at a speed of about 500 r.p.m. and cut the stalks into small pieces. From the knives the cane travels to the crusher. This, in general, consists of two or more deeply-grooved rollers which crush the cane and express a large part of the juice. The crushed cane passes through a series of mills where more of the juice is removed each time until the final "bagasse" (cane fibre) consists of approximately 50 per cent woody fibre. Most plants play a stream of boiling water on the cane in the mills. These mills have three rolls, a rigid bottom roll where the cane enters, another rigid roll where the bagasse is ejected, and a third roll which "floats" and is operated by hydraulic pressure.

The bagasse is either mixed with fuel oil and burned to supply energy to the plant, or is sold to be used in the manufacture of wood substitutes such as "celotex." The juices as they come from the mills must be freed from any remaining bagasse. This is accomplished by passing the juice through perforated brass plates whose surfaces are kept clean by means of moving slats.

Purification of the Juice

The object of this step is to remove from the juice the maximum amount of impurities. In raw sugar manufacture, lime and heat are the agents most commonly used. The juice, after screening, is run into large tanks; milk of lime is added in sufficient quantity to neutralize the organic acids present, and to raise the p^H. This decrease in acidity retards the inversion of sucrose. The temperature is then raised to approximately 200° F. The lime and heat treatment forms a flocculent precipitate of complex composition (insoluble lime salts, fat, wax, gums, and coagulated proteins) which carries with it most of the finely divided substances suspended in the juice.

After this treatment the juice is run into special settling tanks. The clear juice is there decanted from the "mud." This mud is filter-pressed, and the filtrate or "press juice" is mixed with the clarified juice. The mud or "filter-press cake" is a valuable fertilizer.

Evaporating the Juice to a Sirup

In the modern sugar factory the clear juice is evaporated to a sirup in multiple-effect evaporators. The quadruple-effect is the type most commonly used. This evaporator depends upon the fact that the boiling point of a liquid in a closed vessel under reduced pressure is lower than in the atmosphere; and furthermore, the lowering of the boiling point is roughly proportional to the lowering of the pressure. The quadruple-effect evaporator consists of four connected effects (large cylindrical tanks) each having a steam chest. The vapor from the boiler-room enters the steam chest of the first effect and causes the liquor to boil. The steam arising from the boiling liquor in the first effect passes to the steam chest of the second effect where it becomes the source of heat. After giving up its heat to the colder liquor it is liquid water, which is tapped off at the outlet from the chest. The steam arising from the second effect becomes the heating steam in the third chest, etc. The water vapor arising in the fourth effect passes to a condenser, and is liquefied. The temperature of the juice in the first vessel is much higher than that of the juice in the fourth, but the pressure exerted on the liquor in the fourth effect is much less than that on the juice in the first vessel. The same quantity of heat raises steam four times. There is a consumption of heat running the suction-pump, but this is small; the saving of fuel is great.

Crystallization of the Sugar

The sirup from the multiple-effect contains about 40 per cent water. To facilitate the crystallization of the sugar, further evaporation is conducted in a single-effect evaporator, the vacuum-pan. One type of pan is a vertical cylindrical iron vessel with a conical bottom. The vessel contains steam coils, has a valve at the bottom for discharging the sugar, and is provided with small glass plates or windows through which the progress of the boiling can be observed. It is also fitted with a rod for the removal of test samples. The roof of the pan is connected with a condenser by a large vapor pipe and with the vacuum-pump by a much smaller pipe.

The operation is as follows: When the gauge shows a vacuum of 15 to 20 inches of mercury the required amount of sirup is drawn into the pan. Steam is sent through the coils; the temperature and pressure are regulated, and the boiling continued until the splashings on the windows and the withdrawn test samples show that crystals of sugar are separating. At this point the panman raises the temperature of the pan and injects more sirup to regulate crystal growth. This charging of the pan with sirup requires a great deal of skill. The mass of crystals and molasses is called "massecuite." The massecuite is discharged from the pan. This is referred to as a "strike."

Purging the Sugar

The sugar is freed from molasses in centrifugals. The centrifugal is a perforated basket which revolves at high speed. The massecuite is fed into the centrifugal and the machine is spun until the crystals are practically free of molasses. The greater part of the molasses, after being reworked to extract more sucrose, is sold to distilleries where it is fermented to alcohol. The raw sugar, brown in color, is removed from the centrifugals and is sent to the refinery for further purification.

REFINING OF SUGAR

Washing the Raw Sugar

The raw sugar as it is received by the refinery, still contains impurities which give the product a brown color, an odor, and an "off" taste. The washing of the raw sugar is the first step in refining. The raw sugar is mixed with sufficient water to dissolve the film of molasses and a small amount of the sucrose. A heavy sirup results, the "magma." This magma is run into centrifugals, the sirup is removed, and the crystals are washed with a minimum amount of water. The sirup is mixed, in place of water, with succeeding batches of "raws" to form the magma.

Defecation of the Raw Sugar

The washed raw sugar is "melted" (dissolved) in water or "sweet-water" (water with a small amount of dissolved sugar). This solution still contains insoluble material. It is limed, treated with some defecant or filter aid such as kieselguhr, and heated. The heating and defecants cause a coagulation and precipitation of the gums, etc. The liquor is then filter-pressed.

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Some Biological Applications of the Elementary Principles of Physics

● **By George E. Davis, Ph.D.,** *(University of Minnesota)*
DEPARTMENT OF PHYSICS, DUQUESNE UNIVERSITY

Dr. Davis here presents the second and concluding part of his discussion of the applications of certain principles of physics to biology.

He believes that the teacher of biology should give attention to the physical principles involved in biology, just as the teacher of physics must not neglect the biological applications of physics. Both sciences are enriched by considering their interrelations.

In this paper Dr. Davis discusses the effects of radiation on life, the body as a living engine, and the control of body temperatures.

●

PART II

LIFE AND RADIATION

All living things upon this earth depend upon the sun for the energy which makes life possible for them. Without sunshine, all life would quickly disappear. There are two principal reasons why this is so.

Only by virtue of the radiant energy which sunshine supplies can plants manufacture from inorganic materials the starch, sugar, cellulose, protein and fat which are major constituents of their structures and which are the foods of animals. Without these foods which plants supply, animals could not live, since they cannot build their bodily structures nor obtain their energy from inorganic substances. Animals cannot live without plants, plants cannot live without radiant energy; the energy comes from the sun.

Essential warmth comes also in the sunshine. Day after day the sun sends its golden flood of radiant energy to replace that which was lost during the night. Without this constant replenishing of our supply of heat, the surface of the earth would quickly become unbearably cold. Even if food were available without sunshine, life could not long continue at such low temperatures.

Thus, all life looks to the sun. If this should fail, even man with his cunning and his science could not escape the fate of the lowliest blade of grass. The spore of a bacterium might live longer.

Health, too, is partially dependent upon solar radiation, unless artificial radiation of the proper wave lengths is available. It is now generally known that the shorter waves of ultraviolet solar radiation prevent and cure rickets. There also is evidence that man and the lower animals are, in general, beneficially affected by other parts of the solar spectrum as well.

Considering the vital importance of sunlight to all living things, the factors which affect its intensity, spectral composition and use are of the greatest interest and importance. Some of these factors are now considered.

At the surface of the earth, both the intensity of the sunshine and the spectral distribution of its energy are affected by the atmosphere and by the substances floating in it. The floating substances are mostly the liquid particles which form clouds and fog, and the solid particles of dust and smoke. The atmosphere absorbs part of the radiation, the thicker the layer of air, the greater the absorption. Therefore the higher the elevation above sea level and the more nearly the sun is to the zenith, the more intense the sunshine. Material particles floating in the atmosphere also reduce the intensity, both by absorbing the radiation and by scattering it in all directions. The shorter the wave length, the greater the absorption by the atmosphere and the greater the scattering by the particles. Thus, the short-wave ultraviolet, most important for health and most effective in killing bacteria, suffers the greatest reduction in intensity.

Volcanic dust, blown into the upper atmosphere by major eruptions, has been known to reduce the sunshine over the entire earth for as long as a year or two. The smoke of a great manufacturing city greatly diminishes the city's sunshine, seriously affecting the health of its inhabitants. Man has little or no control over fog and cloud. But he can eliminate the smoke from his cities, and he can greatly reduce the amount of dust which blows from vast areas of plowed and uncovered farm land.

Only the radiation which is absorbed by a plant or animal can be used by it, either as heat or as energy which may be necessary in its life processes. This law, which seems self evident, is called the Law of Grotthus.

Radiation falling upon any organism, from man to the simplest one-celled form, is partially reflected, partially absorbed. The relative amounts reflected and absorbed depend upon the smoothness, composition and color of the surface. They vary also with the angle between the rays and the surface. The smaller the angle, the greater the percentage of radiation reflected from the surface, the less the percentage absorbed, and therefore the less the biological effect upon the organism. The radiant energy falling upon unit area of the surface also varies with the angle at which the

rays strike the surface, being proportional to the sine of the angle. Thus both the incident energy and the fractional part absorbed decrease as the angle between the rays and the surface decreases.

Most of the absorbed radiation is converted into heat in the tissues. A very small part may be used in some chemical or physical process which requires energy in that particular form, radiation. If it is a chemical change in the blood, the radiation must penetrate the outer layers of the skin and be absorbed in the tiny blood capillaries which lie in and near the skin.

When sunlight falls upon a green leaf, most of the energy which is absorbed is changed into heat in the tissues of the leaf. A small part is used as energy by means of which the chlorophyll is enabled to change carbon dioxide and water into sugar, starch and cellulose. A little of the energy is used also in forming proteins and fats. The green leaf absorbs principally red, violet and ultraviolet light from the sunshine. These rays are utilized by the chlorophyll in its syntheses. The reflected green light gives the leaf its characteristic color.

The selective use of radiation by the green leaves of plants illustrates the general fact that the biological effects of radiation are not determined merely by the amount of radiant energy absorbed. Each reaction is brought about by radiation of certain definite wave lengths. Other parts of the spectrum have little or no effect. This is illustrated also by the anti-rachitic action of sunshine. The effect is due to a band of ultraviolet light at the short-wave end of the spectrum. Here the radiant energy is very low, constituting a very small part of the total energy of the sunshine. Yet this small part is remarkedly effective in preventing or curing rickets, while all the rest of the spectrum together has little or no effect of this kind.

LIVING ENGINES

Animals are living engines. A steam or gasoline engine ("heat engine") can do work when supplied with the heat energy of burning fuel. Similarly, animals can do work when supplied with the energy which comes from foods which have been eaten and digested. In both the living and the non-living engines, work is accomplished by means of the energy obtained from chemical and physical transformations of certain materials.

But when we inquire into the process by which food gives up it energy to the muscles of the animal engine, we find that it is not a simple burning or oxidation as in the man-made device. Oxidation (of lactic acid) is indeed involved in the process of sustained muscular action, but only in one of those chemical reactions by which the muscle recovers after a contraction so as to be in condition to contract again. The muscle can contract perfectly well without oxidation of any substance. Whereas in the heat engine the heat is the energy used, in the muscles the heat is only a by-product which raises the temperature of the tissues but which cannot be converted directly into mechanical work. Heat cannot be used as such in muscular contraction. Incidentally, heat is produced also in various cells of the body which are not muscle cells, by chemical processes which largely involve oxidation.

The animal is, therefore, not a simple heat engine. It might rather be described as a combination of a slow-burning furnace and an engine which by some chemical or physical process as yet incompletely understood, obtains mechanical energy directly from the chemical potential energy of its "fuel" without changing that energy to heat.

Our knowledge of the chemical reactions involved in muscular contraction, although incomplete, indicates definitely that this is so. But this also can be proven without any knowledge of the reactions involved, by application of a relation in thermodynamics derived by Carnot more than a hundred years ago. Carnot proved that if a heat engine had the greatest possible efficiency, that efficiency would be equal to $(T_1 - T_2) / T_1$, where T_1 is the initial absolute temperature of the steam, exploded gasoline vapor, or other "working substance," and T_2 is the temperature of the substance when it escapes from the engine. Now it has been found experimentally that the efficiency of the human engine varies from about 25% to 35%. Since the working substance (whatever it may be) is at body temperature, 37° C. or 310° absolute, after the contraction, this value can be taken as T_2. Then we have, for an efficiency of 25%, $(T_1 - 310) / T_1 = 0.25$, which gives $T_1 = 413.3°$ absolute, or 140.3° C. This means that the working substance would have to be raised to an initial temperature much higher than that of boiling water, to give the observed efficiency of 25%. Such high temperature is not possible in the body, therefore the body does not function like a heat engine.

However, it has been found by most careful measurements that the total heat produced by foods burned in a calorimeter is, within experimental errors, equal to the total heat and muscular energy yielded by the same foods when used in the body. Therefore it is commonly stated that muscular energy comes from oxidation of foods. But if by "comes" we mean "comes directly," the conclusion is incorrect.

The experimental measurements just cited are the basis for the now general use of the calorie as a measure of food value. But food value is more than heat energy and muscular energy. Foods must furnish suitable materials for repair and growth of bodily structure as well. However, the amount of food used in growth and repair is proportional to the heat energy it would produce if burned. Therefore, it is not particularly illogical to express the value of a food in calories. The resulting popular conception of a calorie is another question.

LIFE AND CONTROL OF TEMPERATURE

Man and other warm-blooded animals maintain remarkably constant body temperatures under widely varying conditions. This is not true of the so-called

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Fundamental Principles or Practical Application in the Teaching of Science?

● **By Sister Mary Geraldine Madden, R.S.M., M.A.,** *(St. Francis College)*
MT. ALOYSIUS ACADEMY, CRESSON, PA.

"Sister Geraldine's excellent paper should stimulate thinking among science teachers generally so that they may never ignore, amid the immediate concerns of the classroom, the more important ultimate objectives of education."

This encomium by the Reverend Felix Kirsch, O.M.Cap., of the Catholic University of America (recently heard on the radio Catholic Hour), makes it unnecessary for the Editor to comment on this article. He knows that it will be appreciated by our readers. It should be read more than once. A single perusal will not suffice for its full comprehension and enjoyment.

●

FOREWORD

"Christian education comprehends the whole sphere of human life, both earthly and spiritual, both intellectual and moral, individual, domestic, and social, not to diminish it in any way, but to elevate, regulate, and perfect it, according to the example and doctrine of Christ.

"The true Christian, the product of Christian education, is the supernatural man who thinks, judges and acts constantly and consistently in accordance with right reason illumined by the supernatural light of the example and teaching of Christ."

POPE PIUS XI—*Encyclical on Education*, December, 1929.

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Which shall we stress, fundamental principles or practical application? Unlike the pragmatist who sets out to be practical and ends by being theoretical, the Thomist starts by being theoretical and concludes by being most practical. We plan to show in this article the danger of overemphasizing applied science; the need of a happy blending in the instilling of scientific principles and the development of right attitudes in the minds and hearts of our students; and the necessity of leaving it to the college to concern itself with practical application. This article is more concerned with the mind of the learner and the part the study of science may play in the development of an integrated personality than with the mere imparting of factual knowledge. Therefore, there is no pretense to give long lists of basic concepts which are an integral part of the various high school sciences and which can be found in any good, modern text of biology, physics, or chemistry.

The teacher of faith and vision will see that once fundamental principles are assimilated, practical applications are only incidental. If not one single benefit ever resulted from an investigation, it would be worth while if it but added to men's knowledge or enlarged their view of the universe, "because it leads them to kneel in adoration before the Infinite." (Pasteur).

Now, what is the danger of overemphasizing practical applications of science? Students form the wrong idea that scientific subjects progress necessarily along the lines of direct usefulness. This is not true. "Very many applications of the theories of pure mathematics and science have come many years, sometimes centuries, after the actual discoveries themselves." (Forsyth). There are needed in the world today men to cultivate science for its own sake. Discoveries, like that of phosphorus by Brandt, the electric oxidation of nitrogen by Priestley, of potassium and sodium by Davy, of aniline by Unverdorben, of benzene by Faraday, and of chloroform by Soubeiran, seemed at the time never likely to be of the slightest use to anybody. The history of science shows that the greatest advances have been made by men who undertook their inquiries into Nature without thought of proximate or ultimate practical application or pecuniary reward. In fact, the best kind of scientific research cannot be carried on in an atmosphere of commercialism, or where personal profit is the end in view.

Another insidious danger in stressing practical application is overemphasizing the materialistic achievements of today. True, this industrial-technical era is the "golden age of scientific discovery," made possible by those intellectual giants who in their own day were utterly unknown, but whom future generations will remember when the mighty warrior, the renowned politician, the famous statesman will have passed into the limbo of forgotten memories. All honor to them, pioneers of the future, who, with no utilitarian concept in view, unlocked for us the treasure house of Nature.

But is the degree of man's conquest of his material environment the sole measure of his progress in civilization? Are we not underestimating an opponent far more inexorable than Nature ever was to primitive man, namely, society? If we concentrate upon the material sphere, what of the ideal enunciated by Pope Pius XI? "Man," Aristotle taught, "is a social animal." Since all science aims to have a more perfect understanding of environments, can we not prevent many later maladjustments? We are too preoccupied with material things and need emphasis on the cultural and spiritual aspects of science. The telescope, made for distant objects, gives a blurred reproduction of reality when brought to bear upon what is near. The mind of man, fashioned for what is eternal and spiritual, falsifies the object and distorts the image when continually focused upon what is material and transitory. Therefore, it is the *spirit* of science and the

many attitudes and methods inherent in that spirit which will equip the student to solve the problems that will come to him in life. True, this stress on fundamentals may not at once secure for him his place amid the modern chaos, but it will send out into the world students refreshed and inspired; it will offer them a much needed respite from a machine age so given to standardization that the individual is apt to be lost sight of.

Confronting the youth of today is a perplexing problem which involves the stability of the whole social organism. This is the temptation to shirk the responsibilities of parenthood in order to retain a position, or to enjoy human comforts and conveniences denied to large families. This problem can be solved only through philosophy and religion. But have these no place in the teaching of high school science? Professor Jennings of Johns Hopkins University, whose authority on matters of science is unquestioned, states:

> "Science, when divorced from philosophy, as it almost invariably is today"—with lamentable results—"inevitably falls a prey to faulty logic, and uncritical metaphysics—in addition to observation and experiment, science has need of far reaching ratiocination for its proper working out."

For every scientist is a philosopher. He begins with facts, rigorously checking his observations. But he does not stop there. He then forms a theory, and as soon as he does, he changes his calling from a scientist to a philosopher, because he is seeking to arrive at an ultimate explanation of some problem. Hence, if our youth in their adolescence when they are still "Sir Galahads in search of the Holy Grail," become saturated with the fundamental principles of truth for the intellect, good for the will, and beauty for the emotions, they will choose the better way; and all the ephemeral glory of possessing the latest mode in clothes, the newest model of a car, the most efficient frigidaire, will pale into dim insignificance before the lasting splendor of the call to cooperate with God in the glorious work of Redemption, and the grandeur of a life of sacrifice that will fill heaven for all eternity with souls He died to save.

Without doubt scholastic methods in the science laboratory will stress important basic concepts. Thanks to Cardinal Mercier the philosophy of Saint Thomas has been brought into harmony with modern science. There is need to inculcate mental discipline and a check on the senses which imparts a self-restraint, a dignity, and a habit of reflective thinking. Professor Whitehead writes:

> "The habit of exact, definite thought was implanted in the European mind by the long dominance of scholastic logic and scholastic divinity; the habit of looking for an exact point and sticking to it."

In these frantic days of superficiality this should suffice to establish the value of scholastic discipline in the science subjects.

Again, may not the study of science help here? It is true that Nature is cold and impersonal; in the laboratory the infinite complexity of human lives, their passions, sins and divine aspirations are absent; still is there not in her objectivity, a wonderful beauty and harmony which is a reflection of the divine? The skillful teacher may lead his students to realize that each unit of high school science has a fundamental meaning which is its innermost reality; that the ideal corresponding to the subject matter must be assimilated together with the skills and methods. The skill gives efficiency, but the ideal gives the force, the hunger, the drive, the inner vision. Skills without ideals flicker out and die. This is exemplified in the lives and works of great scientists of the past. In spite of the fact that Nature is cold and impersonal, human biographies of geniuses who revealed Nature's secrets to us are not. They knew labor, privation, toil, poverty, disappointment, hunger; and all things precious: the applause of the crowd, the glamor of glory, the hope of reward, the love of kindred, were as nothing in the light of the vision that claimed their souls. The teacher of science should communicate their fire to his pupils:

> "Hold high the torch and don't forget its glow.
> 'Twas given you by other hands, you know;
> 'Tis only yours to keep it burning bright,
> Yours to pass on to those who need the light."

Perhaps, the beginner may postulate, that, because of so many sweeping changes the laws of science are mere guesses which may have to be discarded at any moment; consequently, he is wasting his time learning them. Here is where there is need of a solid, scientific creed. New and approved scientific instruments, teaching methods, and equipment are constantly appearing; new problems rapidly follow ever changing conditions; new angles of old problems are forever recurring so that students incorrectly decide that there are no basic concepts of permanence, since they may be so easily jettisoned. Stressing fundamental principles will guard against this fallacy. Professor Millikan writes: "There are no revolutions in science, only evolutions . . . The whole of Newton is incorporated in Einstein." So all the recent discoveries in chemistry only serve to confirm our belief in the fundamental validity of the law of definite proportions.

A concrete example from chemistry may illustrate this point. The atom of today, with the complexities of the neutron, deutron, positron, proton, electron, is no longer the simple, marble-type atom of Dalton. We are familiar with the experiment of Professor Lawrence of the University of California who converted platinum into gold by hurling against it alpha particles with the tremendous energy of 11,000,000 volts in a beam of one-tenth of a micro-ampere. For the type of reaction with which Dalton was familiar his indivisible atom was accurate. He had no way of anticipating radioactivity, or the bombardment of atoms with high speed projectiles or energy waves. In other words, the simple atom served to explain all his observations; consequently, Dalton did not postulate the complex atomic structure with which we are now familiar.

This concept carries us over to another fundamental principle that the criterion of truth is objective evi-

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Demonstrations
In Science Teaching

● **By Sister Mary Ellen O'Hanlon, O.P., Ph.D.,** *(University of Chicago)*
CHAIRMAN, DEPARTMENT OF BIOLOGY, ROSARY COLLEGE, RIVER FOREST, ILL.

Science is made more attractive to students when science teachers teach objectively.

Sister Mary Ellen believes that instructors should familiarize themselves with the many every-day phenomena with which the student comes in frequent contact, which may be used as illustrative material. Some of these common facts and happenings are discussed in detail. Others are suggested. You will be interested in the author's ideas about the results that may reasonably be expected in certain kinds of laboratory work. The danger of presenting a subject in isolated units is pointed out.

This paper was read by the writer at the recent Duquesne University Conference for teachers of science in Catholic high schools. Sister Mary Ellen is well known as an author, biologist and teacher.

The official program of the recent meeting of the A.A.A.S. at Indianapolis gives a fair idea of the rapid advancement in scientific progress and activity in America. This meeting was the one hundred and first meeting of the organization since its foundation in 1848. The association now has an active membership of more than 19,000 scientists representing every part of the world. The organization is in fifteen sections. With its 165 affiliated societies, including duplicate members, its membership is now close to a million. The names of persons delivering addresses or presenting findings of their scientific researches on the Indianapolis program, were well over 1,600. The scientific exhibits and demonstrations as a part of this immense program could not fail to impress the most casual observer with the growth and advancement of scientific thought and action. This meeting, due to its location, was only a kind of culmination to the deep, steady increase of scientific knowledge, particularly during the past few decades.

With the rapid and momentous discoveries of scientific facts and principles, there has developed simultaneously, as the handmaid to skillful experimenters, inventors, and research scholars, more and better technique. This technique is an aid not only to the discovery of the truths of science but also as a most efficient means for demonstrating the facts and findings of the men of science, one to another, and to the layman as well.

All of this progress and the ready demonstrable material must essentially affect both the selection of matter and the methods of science teaching, especially at the lower levels and, in the initial and general courses, at the higher levels as well. There is, so to speak, an embarrassment of riches at our disposal. For with the advancement of the natural sciences and the ever-widening field of each, there has resulted at the same time, in many places, convergences such that the natural sciences now form an almost inseparable alliance. And while specialization is more acute on the one hand, generalization, for a better and necessary foundation, is absolutely indispensable for all who will lay claim to even a modicum of education.

It is plain that there is not at our disposal for the study of this ever-increasing amount of scientific knowledge, a proportionate allotment of time consistent with the former approved methods of procedure even if these methods were now desirable or approved. But, thanks to inventions and many other contributions of practically all the sciences, there is now available for the use of the instructor, ideal projection apparatus of various kinds, micro-photography, color photography, museum preparations, models, charts, moving pictures—all of which help to give general perspectives and short cuts to the spread of knowledge. Besides these formal and less accessible teaching aids, there is at easy reach, splendid scientific matter in the form of magazines and other periodicals, not to mention the regular publications and exhibits for free distribution by so many of our commercial and industrial plants and government offices.

When we add to these efficient helps such devices as a live and progressive teacher will inaugurate from time to time according to his opportunities and his needs, there is an almost endless variety of means through which to disseminate knowledge and to stimulate interest in scientific thought. The task, however, of the present-day progressive teacher of natural science is by no means diminished by the reorganization of the science curriculum; rather it is increased and made more formidable. To hew down a gigantic structure to its essentials and still maintain for it a dignity, a grace, and a solidarity that will support a representative superstructure, is by no means a small order and necessarily demands greater erudition, versatility, and keener judgment on the part of the teacher who will thus succeed. But the genuine teacher is not deterred by changing trends or by new necessities and his own worth will tell, whatever method he may be called upon to employ.

There are many aspects to the matter of teaching or learning through the demonstration method. For example, the demonstrations or illustrations may be controlled exclusively by the teacher or they may be the work of the students previously directed by the teacher. Again, they may be in connection with field work such as visits to museums, conservatories, parks, industrial plants, gardens, orchards, nurseries, forests, etc., where,

in some cases at least, expert guides or technicians act as interpreters.

We shall, however, limit this paper to the technique of class demonstrations in which the teacher and pupils may both participate in varying degrees and methods. Obviously, since the present discussion is one of a biologist, our illustrations for the most part will be applicable to the science of living things. But as all life processes seem to be a complex of physical and chemical reactions, many of which are so mysterious as to baffle the biochemists and biophysicists, we shall concern ourselves here with only a few of the more obvious and better known chemical and physical phenomena, some of which are either directly or indirectly associated with, or definitely manifest in life itself.

Many of the phenomena of practical every day life are splendid illustrations of both chemical and physical reactions, but too often are not regarded by the pupils or even by the teachers of elementary and high schools as being sufficiently dignified or significant to be considered academic problems. We believe that the teacher of the natural sciences, like the instructor of music, art or language, should require some original problems to be worked out and demonstrated by the individual pupils. That is, each pupil should be required to select some ordinary manifestations in nature, in the home or elsewhere, and make sufficient observations and assemble such data as will enable him to put them into the form of a demonstration.

For example, some of the girls or boys may habitually give assistance in the preparation of the family meals. If tomato soup, for example, is to be served, they will learn from their mothers or from the cook book that a little baking soda must be added to the tomato juice before combining it with the milk. Among the organic acids named as being present in the tomato are: glycollic, malic, and tartaric. Reactions between these acids and the sodium hydrogen carbonate result in the formation of salts of these acids, thus leaving no free acid in solution and thereby preventing the curdling of the milk. The two types of proteins in milk, are coagulated by different means: casein is curdled by an acid, while the other two, lact-albumin, and lact-globulin are coagulated, like egg albumin, by heat. This brings us to the homely process of the making of cottage cheese. The skimmed milk is soured in this case through the activity of the simple plant organism known as the lacto-bacillus, and the lactic acid formed from the sugar of the milk brings about the curdling of the casein. The making of this kind of cheese is completed by heating the curdled sour milk in order to coagulate the albumin and globulin. The differences between the milk that is curdled by the addition of an acid, for example, vinegar or lemon juice, and that naturally soured through the formation of lactic acid from the milk sugar, form an interesting comparison and study.

In the matter of the making of bread, the fermentation of fruit juices, or the brewing of beer, the same chemical processes are at play in so far as the yeast organism is concerned. Every one readily distinguishes yeast-made bread from the various kinds of quick breads, or crackers. These three types differ greatly in appearance, taste and texture, in spite of the fact that they may be made from the same kind of flour mixed with water as the principal ingredients. To be good and tasty, all three kinds must be light and porous, that is, they must be, when baked, full of small compartments of air. Both the chemical and mechanical or physical processes employed in the making of these breads differ greatly, thus bringing about results that are easily distinguished by the smallest child.

In the first place, the so-called cracker is made of little else than flour and water, usually, and the aeration is effected by mechanical means. In yeast-made bread, there may, or at least there need not be other than these two principal ingredients. The essential differences between yeast bread and crackers are due to the fact that the porosity of the former is brought about through the escaping carbon dioxide gas which is a result of the fermentation of sugar caused by zymase, one of the enzymes of the yeast, the sugar having been previously developed from the starch of the wheat through the activity of another yeast enzyme called diastase. Yeast fermentation is generally known as the breaking up of sugar into alcohol and carbon dioxide through this organic catalyst called zymase.

Moreover, the mechanical kneading of the bread-dough brings to completion the reaction between the gliadin and glutenin, the two constituents of the protein gluten in wheat flour. Gluten accounts for the spongy, rubbery texture of yeast bread-dough, giving it its characteristic appearance and taste. Quick breads, such as baking powder biscuits, muffins, and the like, are leavened by direct chemical means, the usual chemicals being the constituents of baking powder; for example, sodium hydrogen carbonate or baking soda and potassium hydrogen tartrate, or cream of tartar. Their reaction results in the formation of sodium potassium tartrate (Rochelle salt) and carbonic acid, the latter breaking up into carbon dioxide and water. Thus, we have two type cases wherein the liberation of carbon dioxide gas is responsible for the porosity of bread, but in which this gas is developed in very different ways. In the one, it is caused by an enzyme, that is, a ferment or an organic catalytic reagent, while in the other, the carbon dioxide is set free as a by-product of the reaction between two inorganic salts.

The kneading of the dough in the case of quick breads is undesirable because much of the carbonic acid gas is thus formed and evolved before the dough is put into the oven; consequently its purpose is frustrated. The rapid gas formation, too, as in the case of the chemically leavened breads, such as biscuit and muffins, is the reason for the high-temperature oven in the case of these so-called quick breads. The omission of the kneading or violent mixing of the chemically leavened breads, however, leaves the reaction of the two constituents of the gluten incomplete and is responsible especially for their very different textures and tastes.

When bread-dough, that is, a stiff flour and water mixture is put into a cheese cloth bag and washed and rubbed in cold water until the starch grains pass through the meshes of the cloth, there remains a yellowish, rubbery mass, which is more or less pure gluten. When this gluten is baked, it expands to form an almost hollow ball and resembles an animal membrane. Incidentally, a drop of the starchy water may be mounted and examined under a microscope and compared with corn or potato starch grains. The starch grains of different plants are so characteristic in each species as to be quite diagnostic. While the microscope is at hand a bit of yeast rubbed up in water will exhibit yeast cells (some budding, if taken from an active culture), and the wheat starch grains that have been supplied by the flour. A drop of iodine solution will set them off from the yeast cells and whatever foreign substances may be included. If the pupils try to test rye flour in the manner here described, they will find that so little of the glutinous substance is present that their results will be negative. This is the reason why yeast bread cannot be made successfully from rye flour alone and, generally, the so-called rye bread is made of equal parts of wheat and rye flour in order that the elasticity of the dough will be sufficient to hold the carbon dioxide gas formed by the relatively slow process of yeast or alcoholic fermentation. On the other hand, macaroni and its kindred food commodities are manufactured from wheat flour that is particularly rich in the gluten constituents as compared with the ordinary bread flour and the still more starchy types of flour that are best for cakes and fancy pastries. This leads us into the domain of the agriculturalist, introducing the subjects of winter wheat, and spring wheat, and many other topics.

In the ripening of fruits and the further hydrolysis of the disaccharide sugars in some of these fruits, as well as the disaccharides that are added when these fruits are cooked, we have splendid chemical reactions that are most interesting and give results that are very easily observed. Every child realizes that certain of the small fruits, such as cherries and berries are much sweeter before being cooked, even when some sugar is added in the cooking. They may have observed that sometimes these fruits are cooked without the sugar, the latter being added in the form of a syrup later. The reasons for all these things are definite and important and are sure to attract attention and to challenge curiosity.

The home, and especially the kitchen, is a splendid laboratory in every sense of the word, for any girl or boy to apply many of the basic principles of organic chemistry and physics. Thus the tie-up between what is learned in scientific terminology and with mathematical exactness in the class room, becomes real and practical and lends dignity and promotes greater respect for the most ordinary activities and duties in the home.

Some of the boys may become interested in dairying, baking, brewing, or any other of the great food industries; all of the girls should be interested in the countless applications of the sciences in relation to the immediate preparation of foods and clothing and to home management. All are living and will continue to live in homes or institutions which must be properly heated, lighted, ventilated and kept sanitary. What a place is the modern home with its telephone, frigidaire, radio, vacuum cleaner, and the countless other electrical appliances and equipment, to apply the knowledge, the fundamentals of which are acquired in the more formal way in the classroom.

Both boys and girls should be encouraged, according as conditions may permit or require, to learn to wash the dishes after the family meals. Perhaps purple cabbage was served as a tart salad. The sour juice of such a salad is a rich reddish-purple; but when the dishes which have been soiled by it are put into the soapy water, the color change is so striking as to prove that this plant juice is as good an indicator as the litmus preparations, or some of the synthetic indicators which are employed to determine p^H values in the laboratory. This may stimulate them to find other plants the juices of which also may serve as indicators. If they have access to a reference library, they will find a long list of plants, which in one organ or another, contain juices which serve as good indicators.

When eggs have been a part of the menu and the silverware is tarnished as a result, some of the students will tell you that this dark deposit on the forks and spoons is silver sulfide, the compound formed by the reaction between the sulfur from the cooked eggs and the silver plating of the service. If the process of electrolysis has been discussed or demonstrated previously in the classroom, the pupils can try out this experiment by placing the discolored silverware into an aluminum vessel containing a salt solution, together with a piece of zinc or simply the castoff lid of a mason jar, which is made of zinc. Through the process of electrolysis the silver and sulfur will become dissociated and the sulfur will be deposited upon the more more active zinc, leaving the silver plating of the forks and spoons bright and unharmed.

Many common physical phenomena can easily be demonstrated with little or no commercial apparatus; for example, the expansion of water as it approaches the freezing point, evaporation, condensation, crystallization, distillation, determination of wet and dry weights of various articles and substances, the applications of the different weights and measures, the melting and boiling points of the different common fats, and other substances which are solids at ordinary temperatures. Indeed, a textbook of science should be suggestive, consultative and confirmative rather than slavishly followed.

A simple and rather spectacular demonstration to show how nature abhors a vacuum may be done very effectively before a class. Take a tin can, preferably the type in which ether, methyl alcohol, varnishes, etc., are sold, with a capacity of two gallons or more and

fill it not more than a quarter full of water, hot water, in order to save time. Continue heating the open can until the steam escapes in clouds and then remove it from the flame and close it air tight. Allow it to cool, the more quickly the more spectacular will be the result as, for example, by setting it out of doors on a cold day or by plunging it into a basin of ice cold water. As the steam in the air-tight can condenses, the sides of the container collapse until the can has the appearance of having served as a football for several small boys. When the can is replaced on the flame, the evolving steam will again inflate its compressed sides. Care must be taken, however, that too prolonged re-heating does not result in an explosion.

Such a demonstration made before a class without any explanation other than a previous study of the principles involved, will tax their application and interest more than any amount of experimental work which is carefully dictated step by step in some textbook or laboratory manual, and which is, after all, more or less the "cook-book" style of procedure. In the majority of cases laboratory problems, due to their sequence, etc., must be so stated that the results are a foregone conclusion, at least for the brighter children; and for the duller ones, the whole procedure is more or less of a task which must be executed by hook or by crook.

We are convinced, therefore, that there should be at least one original problem or experiment or demonstration,—call it what you will,—to supplement, or better still, to substitute for the so-called required experiments. It would seem better pedagogy if, after studying an experiment or exercise as outlined or described in a text or manual, the student formulates an original one to illustrate the principles involved, rather than performs the exact experiment, as prescribed in the course of study. I am convinced, as the years pass, that much of the laboratory work done in our schools, and colleges, too, is wasted time and is not productive of the right kind of results. Many laboratory exercises are simply cases of putting in time and turning out a notebook with results that will pass muster and results, too, that have been obtained by the slavish pursuance of a work book or manual, not to mention the borrowed and copied data that pass for original work. These things are bound to occur no matter how cautious or vigilant the teacher may be. Many of the experiments in chemistry and in physics particularly, were better performed before the class by the teacher with the assistance of the more capable students, or by such students themselves with wise and thought-provoking questions on the part of the teacher as the experiments proceed. Better results will be obtained with much greater economy of time and space and merely the minimum amount of equipment. Those experiments which call for mathematical calculations may be completed in the same period—each pupil shifting for himself but with the same data.

If I may be pardoned for relating a personal experience as a student in elementary chemistry, I think that my point here will be more acute. I recall being obliged to determine experimentally the hydrogen equivalent of magnesium. While not directly practical, such an exercise has its place in a chemistry course, I admit; but not alone because it is prescribed unless there is at hand the adequate equipment with which to arrive at results that will be reasonably exact. One of my difficulties was that the balance at my disposal was inadequate, first, because it was not sufficiently sensitive and, second, because it was not in excellent working order; but probably my greatest difficulty was the fact that I was too much of an amateur to use it successfully. All of these discrepancies I noted and therefore did not hope, unless by some happy accident, to obtain results that would at all coincide with the accepted values. It happened that my mathematical training was superior to my ability to adjust a delicate balance properly; so I set out to figure just what results I should have obtained with the known weight of magnesium that I had used. I also realized from former experiments, that a certain reasonable error was acceptable; so I proceeded to juggle, not the apparatus, but my figures of weights and measures, until I had arrived at what I considered respectable results. Furthermore, my right hand neighbor was much worse off than I, since her mathematical inclinations were less acute than my own and, of course, the balance would serve her no better. So I proceeded to give her a lift with her weights and measures. The results were that we both received high grades for our experiment. To this day I have no regrets for this kind of deception. Whether I would repeat the same kind of thing were I to find myself in a similar situation is of no concern here, but let it serve the purpose of helping you to decide what you will and what you will not require of your students; what may be practical and real, and what is impractical and next to impossible.

The demonstration is and has always been the method of teaching science in European schools, especially at the lower levels, and it occupies a very important part of every lecture in the universities. The European professors have well-trained technicians who assist with the demonstrations and are responsible for the set-up and care of all apparatus. They serve as hands and feet for the professor during the lecture-demonstration and are altogether indispensable both in the laboratory and in the lecture room.

As for the biological aspects of science teaching, especially those features which have to do with form and structure, and many of the biological principles that are very obvious such as symmetry, metamorphosis, metamerism, embryogeny, protective coloration, mimicry and camouflage, regeneration, plant and animal forms, and many of the ecological aspects of living things, as well as comparative morphology and embryology, all can be demonstrated without great difficulty or expenditure of money, if only the teacher is sufficiently trained and a bit resourceful. The few homemade charts and posters that we submit for your examination will suggest the variety of sources from which the material was drawn and the small expendi-

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Science in the Laundry

● By Florence A. Obert
THE BISHOP McDONNELL HIGH SCHOOL, BROOKLYN, N. Y.

Each year, as a feature of its Science Conference, Duquesne University conducts a national essay contest for students enrolled in science classes in the Catholic high schools of the United States. Members of the faculty of Duquesne University act as judges.

This year, the award of the gold medal, signifying highest honor, was made to Miss Florence A. Obert of Brooklyn, N. Y. Five honorable mentions, all of equal value, were awarded to students in high schools located in Conway, Ark.; St. Augustine, Fla.; Aurora, Ill.; Chicago, Ill., and Lock Haven, Pa.

A silver cup, for one year's possession, was awarded to Miss Obert's school, the Bishop McDonnell Memorial High School. Sister M. Thomas Aquin, O.P., was Miss Obert's supervising teacher.

The essay appears in its original form. It has not been edited.

●

"Cleanliness is next to godliness" is an old adage that might be taken as the motto for a modern laundry. An appalling portion of man s allotted span of life is spent in the struggle with dirt, a struggle in which victory means triumph over disease and other menaces to the well-being of man. A realization of the importance of cleanliness is traceable to the early days of man's history. History shows peoples sloshing clothes in running brooks, pounding the dirtiest ones with stones, bleaching others in the bright sunshine — activities carried on in the first outdoor laundries. In this scientific age, however, man is not satisfied with the slow, laborious, crude processes of his forefathers. Science is invited to become the handmaid of progress. Biology, chemistry, physics — all have been called upon to contribute their quota of scientific principles to make modern laundering the quick, safe, efficient process it is today.

FLORENCE A. OBERT

Miss Obert is president of the senior class, a member of the staff of the school paper, Catholic Action representative, and secretary of the Albertus Magnus Science Club. She is seventeen years old.

Biology, through microscopy, gave an understanding of the structure of textiles. Viewed under the microscope, the warp and structure of cloth, the mesh of cotton, wool, silk, rayon, and other fibrous substances were revealed to the scientist. A better understanding of this structure brought about a clearer view of the science of keeping these textiles clean.

Biology, through bacteriology, gave another contribution. Dirty clothes were found to be breeding places for bacteria that cause various diseases. The clean, bright, sunshiny laundries with their sanitary precautions to prevent the growth of bacteria, their hot water, soap, bleaching agents, and heat, bringing death to bacteria, have done their full measure of work to prevent the growth and spread of disease.

Chemistry plays a very important role in the modern laundry. Water has always been a universal solvent. Water, especially soft water, is still the primary cleanser. The one characteristic of water that tends to retard its usefulness in the laundry is temporary or permanent hardness. Hardness is due to the presence of compounds of lime and magnesium. Temporary hardness may quickly be removed by boiling the water. Permanent hardness prevents the water from reacting with the soap, and forms a scum which may impregnate the cloth. To counteract permanent hardness small water-softening plants composed of a substance known as zeolite are used. This compound is insoluble in water, but it reacts with the lime and magnesium in the water, exchanging an equivalent amount of sodium. This is an excellent example of a chemical reaction brought to the aid of man in the laundry.

A very important agent in the laundry is soap. This is prepared chemically by the reaction of an alkali with oils or fats. Originally the housewife made her own soap from the greases of the kitchen,

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You Should Read . . .

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The Machinery of the Body

● *By* ANTON J. CARLSON and VICTOR JOHNSON, the University of Chicago. Chicago; University of Chicago Press, 1937. xvii + 580. Illustrated. $4.00.

The University of Chicago Press presents another of its notable series of new-plan textbooks in the biological sciences. It is designed for college students who seek a broad view of a whole field rather than detailed information concerning restricted portions of it.

This book treats of human physiology as a science founded upon experimentation. Principles are stressed, details avoided. Much recent material is included. The 187 illustrations are new and well chosen. The authors have attempted to present their material in a way that can be understood by readers who have had no previous knowledge of physics, chemistry, or biology. On the whole they have succeeded very well.

This book will make an attractive college textbook. It will be a useful addition to the high school library.

H. C. M.

●

Biology for High Schools

● *By* BROTHER H. CHARLES, F.S.C., Department of Biology, St. Mary's College, Winona, Minn. Published by the author. 1937. 144 pp. Illustrated. Price not listed. Planographed edition.

No less an authority than Dr. Robert Maynard Hutchins of the University of Chicago has declared that the presentation of facts and principles within the covers of texts for the consumption of youths at public and private schools has developed into a mild "racket" in America. With this charge we agree to the extent that our pedagogs have tended to lean too heavily on the ideas in the text to the detriment of their own constructive thinking and that of their learners.

High school science texts containing voluminous pages have been produced in over abundant quantities without meeting any significant need. They have served merely to clutter up the desks and minds of young people and teachers. Close analysis of competitive texts in related fields reveals too often that the structure, the content, and the methodology have changed slightly in fundamental respects. One may have a more dynamic title than another, or present facts encompassed by a more vividly colored cover that rivals in format some of the best known commercial, fictional publications.

Science teachers are beginning to grow tired of the steady, wearisome diet of monotonous treatment of lively topics. They are searching for something more real, more stimulating, yet scientifically accurate.

Brother Charles has produced a notable contribution. He has taken the fundamental biological concepts and integrated them in a masterful manner with the realistic problems of life. The sections devoted to Adaptation, Food Fads, Mental Health, and Occupational Hazards deal with vital subjects in a most engaging style. Instead of trying to anticipate all of the prospective questions of students, and then attempting to provide answers that are often too feeble and too inadequate, he has adopted the technique of motivating the learner by challenging his own innate and acquired capacities for systematic reasoning. The teaching defects of the usual texts and workbooks have been eliminated.

A planographed supplementary manual for teachers suggests ways in which to encourage purposeful activity that will train the mechanical aptitudes and thought processes of youths. The book is certainly worth trying in any high school.

H. J. LEAHY.
School of Education
Duquesne University.

●

Handbook of Chemistry and Physics

● *By* CHARLES D. HODGMAN, M. S., Editor in Chief. 22nd Edition. Chemical Rubber Publishing Company, Cleveland. 1937. xvii + 2069. $6.00.

No book, which has reached its twenty-second edition, needs extensive comment from any reviewer. Such wide use speaks for itself. Some 173 specialists compiled the chemical, physical, mathematical, and related scientific data that appear in the 1937-38 edition of this valuable reference book. Certain tables appear in a revised, enlarged, and extended form. New data are given concerning foods, viscosity, flame spectra, radio tubes, the solar system, the earth, and the atmosphere.

J. F. M.

●

How to Use the Educational Sound Film

● *By* M. R. BRUNSTETTER, Ph.D., Director, Bureau of Publications, Teachers College, Columbia University; The University of Chicago Press, Chicago. 1937. xiii + 174. Illustrated. $2.00.

Up-to-date instructors always are seeking new teaching aids. Among the newest available are educational sound films. Special skill is required in their presentation if the best results are to be obtained. This book, written by a former Research Associate of the Erpi Picture Consultants, Inc., contains the results of much study and experimentation with these audio-visual aids. Its reading will save teachers and administrators from making many mistakes.

Dr. Brunstetter discusses sound-film materials of instruction and their teaching purposes, the special techniques of teaching with sound films, how to organize a program of instruction, and how to train teachers in the use of these aids.

There is a Foreword by Alexander J. Stoddard, superintendent of schools, Providence, R. I. An outline of a typical unit, "Work of Running Water," to be taught with sound film, appears in the Appendix.

H. C.M.

Gardens of Middle Ages

(Continued from Page 39)

ing from 1165 A. D., bound in the Great Psalter of Eadwin, preserved at present in the library of Trinity College, Cambridge. The plan was probably made by the engineer Wilbert, or his assistants, to explain the water arrangements, perhaps because repairs were needed. Fruit gardens and vineyards were shown outside the walls. In one court beside the east wall there was a very large basin marked "Piscina," intended for fish breeding, a very important business in the English monasteries. The churchyard for the laity, lay to the north and had its own special well. The infirmary overlooked a large court containing the "Herbarium," cut across the middle by a covered walk or pergola, that had its water arrangement on one side, while the monks' burying ground with a separate water system lay on the other side.[14]

There was another orchard on the west of the great cloister and a garden into which the Archbishop could gaze from his palace. These were beyond the limit of the plans, although contemporary with them, for they were associated with the closing scenes in the martyrdom of St. Thomas a Becket in 1170 A. D. The knights who murdered the Archbishop

> "threw off their cloaks and gowns under a large sycamore in the garden, appeared in their armor and girt on their swords. Armed men were collected in the orchard, so that St. Thomas a Becket and his attendant monks fleeing to the church, had to pass through a small door at the back of the cloister instead of going by the usual passage through the orchard to the west end of the church."[15]

As was the case in Spain, the monastic gardens apparently yielded a rich harvest of fruits. The Domesday Book (11th century) enumerated 38 different vineyards in 38 different sections of the country. They ranged in area from one acre to twelve acres. The quantity of wine, if the season was favorable, was from 20-40 gallons. Gloucestershire was famous for its wines and William of Malmesbury wrote that "their wines do not offend the mouth with sharpness, and they do not yield to the French wines in sweetness."[16] Ely long continued to be famous for its grapes, and the Normans called it "Isle des Vignes." Matthew Paris, in recording the ungenial season of 1257 A. D. writes: "apples were scarce, pears still scarcer, but cherries, figs, and all kinds of fruits included in shells (filberts, walnuts, etc.) were almost destroyed."[17] The Wardon pear which was a favorite for centuries originated in the Cistercian Monastery of Bedfordshire. It was a kind of cooking pear and every early cookery book contained recipes for "Wardon pies" or pasties.

In all ages, flowers have borne an important part at ceremonies, and England in the Middle Ages was no exception. The use of flowers to decorate the altars, to make the "coronae sacerdotalis" and to wreathe shrines, candles and banners was very general. As has been previously stated, the garden plots for providing flowers for the altar, were under the care of the sacristan. There was a "gardina Sacristae" at Winchester as early as the 9th century, and to this day a piece of ground on the east side of the north transept of the Cathedral bears the name of "Paradise" and marks the site of the sacristan's garden. Henry VI of England left such a garden to the church of Eton College. The clause of his will ran thus: "The space between the wall of the church and the wall of the cloister shall contain 38 feet which is left for to set in certain trees and flowers, behovable and convenient for the service of the same church. It is to be surrounded by a good high wall with towers convenient thereto."[18]

Each obedience or office in a monastery was directed in a regular and orderly way by a presiding officer with set duties, who had to keep the accounts of his office and was responsible for its management. The Gardinarius, or hortulanus, or garden warder, had charge of the herb and flower gardens, the orchards and vineyards. Two very perfect series of monastic garden accounts are those of Norwich Priory from 1340-1529 A. D. (about 30 rolls of manuscripts) and those of Abingdon Abbey (four accounts) dating from 1369 A. D. Quite logically, the accounts stressed some items without variation every year, e. g., payment of laborers, tunics, boots, gloves and expenses for the yearly feast. There were yearly variations for tools, saws, knives for herbs and grafting, hatchets, repairs of the garden wall, locks and keys for gates. Payment of laborers varied. The two laborers at Romsey Abbey (circ. 1170 A. D.) who assisted the gardeners received fourteen loaves each and two acres of land. The accounts throw little light on the processes of cultivation and do not specify the flowers and plants grown.

The search for truth and beauty that motivated the activities of the monks in their religious life, left its seal also on their labors in the gardens of the period. Unselfishly they diffused their gardening knowledge everywhere by writing many of the earliest botanical books. In the 9th century Hrabanus Magnentius Maurus compiled a famous plant encyclopedia. Most of the information he culled from the 17th book of the *Etymologiae* of St. Isidor of Seville who had, in turn, secured his material from Theophrastus's *Inquiry into Plants* and from Pliny the Elder's *Natural History*. Walafrid Strabo of Suabia (10th century A. D.) abbot of Reichenau, biographer of Charlemagne, wrote *Hortulus*, twenty-seven poems, each one of which is a description of a plant he grew in his garden, such as: sage, rice, southernwood, poppy, pennyroyal, mint, parsley, gladiola, lilies, roses, etc. Alexander Neckham, foster brother of Richard Coeur de Lion, Abbot of the Augustinians at Cirencester (13th century), wrote *De Laudibus Divinae Sapientiae*, a poem in ten books, of which the seventh was devoted to herbs and fruits, and *De Naturis Rerum*, which was concerned with laying out gardens. Here he suggested that "the gardens should be adorned with roses, lilies, violets, mandrake, poppy, daffodils, medlars, quinces, Wardon trees, peaches, pears, pomegranates, lemons, oranges, almonds."[19] Bishop Groseteste of Lincoln (12th cen-

tury A. D.) adapted the work of Palladius, *De Re Rustica*, to English conditions and later Nicholas Ballard a monk of Westminster transcribed Palladius's instruction for grafting and setting out trees, thus spreading to all gardeners the knowledge of this art. St. Albertus Magnus, the Dominican (13th century A. D.), one of the greatest of medieval scholars, wrote learnedly on plants. Legend says he did more. He revived the Roman practice of forcing fruits and flowers in a hot house. So successful was his "under glass gardening" that he was accused of witchcraft. When King William of Holland visited the Dominican Convent in Cologne in 1248 A. D. it is said that

> "the dead dank shrubs and trees in the garden blossomed with Maytime luxuriance. The far flung corners of the world leapt to the cloister garth, suddenly transformed into a veritable conservatory of the most exotic plants and flowers. The bare trees stretching out their arms to heaven in mute protest against the wintry death began to sag under the weight of fresh luscious fruits. Birds came back in 'the twinkle of an eye'; butterflies, more radiant than a dream, dazzled the eyes; fountains with the force of geysers, lept into the air to catch the kiss of the sun and spread themselves in mad joy in gossamer veils of dancing color. At a table in the center of the garden, two handsome youths, like Greek gods, strayed into an alien land and home, served the king with food which only a minute ransacking of the world could have brought together."[20]

The Monastic Garden of the Middle Ages was indeed a garden of delights. Its quadrangle open to the sky, adorned with trees and shrubs and flowers that bloomed and blossomed the year round, served to remind monks and people of the beauties awaiting them in the eternal gardens of heaven.

(To be Continued)

REFERENCES

1. Hallam, H., *History of Europe during Middle Ages*, p. 7.
2. Crisp, Sir F., *Medieval Gardens*, Vol. I, p. 13.
3. Wright, R., *Story of Gardening*, p. 90.
4. Butler, C., *Benedictine Monachism*, p. 308.
5. Gothien, M. L., *A History of Garden Art*, Vol. I, p. 178.
6. Gothien, M. L., *A History of Garden Art*, Vol. I, p. 178.
7. Ibid. p. 174.
8. Gothien, M. L., *op. cit.*, p. 178.
9. Sievcking, A. F., *Gardens Ancient and Modern*, p. 32.
10. Reichau, Hans, *Alte Burgerliche Gartenkunst*, p. 6.
11. Amherst, A., *History of Gardening in England*, p. 5.
12. Ibid. p. 7.
13. Gothien, M. L., *op. cit.* p. 178, Vol. I.
14. Ibid. p. 176.
15. Amherst, A., *op. cit.*, p. 7.
16. Ibid. p. 9.
17. Johnson, G. W., *History of English Gardens*, p. 40.
18. Amherst, A., *op. cit.*, p. 16.
19. Crisp, Sir F., *Medieval Gardens*, Vol. I, p. 41.

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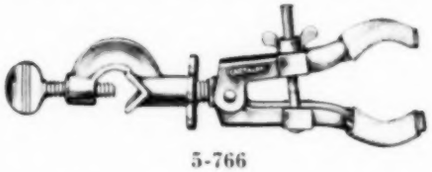

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Fundamental Principles

(Continued from Page 46)

dence, and when in due time facts arise that are contrary to a theory, the theory must be held untenable. It is easy to teach youth that as the power of seeing is enlarged by the improvement of instruments or the development of methods of inquiry, new spheres are brought within the range of human knowledge. So the search for truth continues. It is the successful or the unsuccessful pursuit of truth which gives happiness to each generation of scientific men, and not the value of the truth itself . . . the energy, the doing, not the thing done. "If a time could arrive when all is known, when there could not be a new investigation or experiment, our keenest pleasure would end. We may, therefore, feel happy in the thought of how much is still unknown." (A. G. Vernon Harcourt). Is it not within the purview of high school science to inculcate this principle?

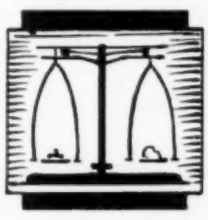
It is perfectly obvious that we must instil a reverence and respect for the contribution of science to the home, to health, to industry, to commerce, and to agriculture. All real men of science are well aware of the limitations of science, but at the same time are deeply appreciative of its blessings to humanity. The practical value of science lies in the improved utilization of the limited store of raw materials and of raw energy. It is not surprising, therefore, that nations today struggle for control of natural resources. And it is inevitable that the progress of material civilization depends more and more on the development of physics and chemistry. Each day raw materials and raw energy are being synthesized into better devices, into more useful slaves of men. Chemistry and physics are truly men's arsenals, storehouses of Nature's secrets, and producers of the weapons that the engineers, farmers, doctors, and industries use in the tremendous struggle against her. Thus, one potent purpose of high school science is to teach men to understand their environments, and to dominate them. With the development of fundamental principles of science, then, we can look forward to a life in which living will be not only freer, fuller, happier and more graceful, but also holier.

It will be holier if we read in the order and beauty in the universe the very mind and will of God. What are the laws of science if not the innate harmonies of nature? Is not chemical activity the striving of the atom to seek the symmetry, the perfection, of a completed "outer orbit"? Is this not indicative of our own struggle towards union with God? For as we examine the absolute lack of chemical affinity of those atoms that have already completed outer shells (Helium, 2; Neon, 2, 8; Argon, 2, 8, 8; Krypton, 2, 8, 18, 8; Xenon, 2, 8, 18, 18, 8, and Radon, 2, 8, 18, 32, 18, 8) we note they have no desire to unite with any other element. Is it not within the purview of science to draw an analogy showing that one totally absorbed in a supernatural ideal, regardless of the field of his activities, preserves his mental poise and balance amid "the slings and arrows" of life which will not lightly pass him by? He is absolutely indifferent to public opinion when he knows he is right. This is not sheer stubbornness, but integrity or loyalty to personal inspiration, the root of an uncompromising attitude so much needed in our youth today.

Consequently, can we not see that one of the major outcomes of this emphasis upon fundamentals is an integrated personality? For the student must create his own personality; no one can do it for him. There are within him vital energies (not merely physical but mental), which work spontaneously to this end. It is a glorious opportunity for the teacher of science to cooperate with these God-given energies, directing them to creative channels, thus conserving them, and using them to the highest advantage. And as our pupils gaze in wonder at the marvels science has wrought, they will realize that their own innate potentialities will become actualities only by obeying the laws of God and man, for the work of the world will always be done. Someone will be found to stoke engines, to fire furnaces, to build bridges, to construct highways, to write poems, to paint pictures, to nurse in hospitals and to teach in our schools. What God asks is this: that this someone who serves humanity will be a man of nobility and integrity.

Is it "unscientific" to conclude that nature reveals God just as any great painting reveals the artist, as every monument the architect, and every machine the inventor? The universe, according to original design was transparent, like a window pane, through which we could see the Wisdom, the Power, the Beauty of God. The mountain, His strength, the stars, His loveliness, the sea, His eternity, the flowers, His sweetness, the Sun, caressing all things, His love; everything was a reflection, a revelation of some divine attribute. The world lost its transparency and became opaque through sin. A veil was drawn between the artist and His artistry. The sense of the invisible was lost. To God through things became impossible, until one day Christ, the Master Scientist, walked the earth and taught us once more to pierce reality. Thus, should we lead our pupils to find God. It is told of Michelangelo who, old and blind, touched one of those inspiring marbles into which Phidias breathed his immortal genius, and said: "Great is the marble, great is the sculptor, but ah, greater still is God, I learn . . . I learn."

May not the student in his own workshop learn a like reverence?



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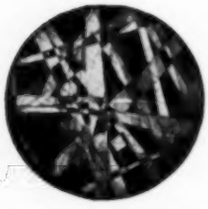

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Biological Applications

(Continued from Page 44)

cold-blooded animals, such as fish, reptiles and insects, whose temperatures are approximately the same as those of their surroundings.

To a living creature, temperature is of vital importance. When its temperature decreases, the chemical reactions of its life processes are retarded, its muscles and other tissues become more viscous, and as a result its movements and all its reactions are slowed. A house fly, swept from the wall on a cold morning, is a victim of viscous muscles and inability to react to the menace of the approaching broom. An ant runs faster and does a bigger day's work when the day is hot.

Thus, the cold-blooded animal is at a serious disadvantage when the temperature of its environment differs markedly from the optimum value. On the other hand, a warm-blooded animal, maintaining a nearly constant temperature in heat and in cold, varies little in its activities and speeds of reaction. This is most advantageous. But also it involves the possibility of failure of the temperature-controlling mechanism when demands upon it are too severe, with results which may be fatal.

Heat is produced continuously in all living things, by metabolic processes (mainly oxidation) in the tissues. Therefore, the temperature of an animal or plant is dependent not only upon the environmental conditions but also upon the rate at which heat is produced within it.

The human mechanism for control of temperature is generally similar to the mechanism of other mammals. Several well known principles of physics are utilized. The mechanism is highly complicated, involving a number of involuntary reactions. Conscious control of bodily actions and environmental conditions also may be brought into play.

One or more of the following principal voluntary and involuntary reactions may be used to prevent the body temperature from becoming too high:

(1) Excretion of perspiration, which cools by evaporation;

(2) Expansion of the capillaries of the skin, allowing blood to come near the surface and be cooled by conduction and radiation of its heat to the air and surrounding objects;

(3) Increase in rate of breathing, with increased cooling by more rapid evaporation of moisture from the lining of the lungs and respiratory passages;

(4) Decrease in muscular activity, with resultant decrease in heat produced;

(5) Removal of clothing, to allow more rapid loss of heat by conduction and radiation and more rapid evaporation of perspiration.

When the body temperature tends to become too low, the following reactions are employed to prevent it:

(1) Contraction of skin capillaries;

(2) Voluntary increase in muscular activity, or the involuntary muscular contractions of shivering;

(3) Increase in clothing.

Control of temperature also may be effected in part by regulating the temperature of the surroundings, by increasing or decreasing the movements of air striking the body, by regulating the temperature of food and drink, etc.

In thus regulating the temperature of the organism, the following principles of physics are brought into play:

The evaporation of moisture from the skin and respiratory passages cools effectively by utilizing the heat of vaporization. If the surface is assumed to be at the normal body temperature, 37° C., then approximately 576 calories of heat are lost for every gram of water evaporated.

Increasing the movement of air over the surface of the skin, as by the use of an electric fan, increases the rate of evaporation, hence the rate of cooling.

Radiation of heat from the surface is proportional to the area exposed and approximately proportional to $T_1^4 - T_2^4$, where T_1 and T_2 are the absolute temperatures of the body surface and its surroundings, respectively. The loss of heat, Q, in calories per sec., is given by $Q = K A (T_1^4 - T_2^4)$, where A is surface area, in sq. cm., and K is a constant equal to 1.3×10^{-12}. For example, if 600 sq. cm. of surface are exposed on a day when the temperature is 283° absolute (= 50° F.), and if the skin temperature is 300° absolute (= 80.6° F.), the loss of heat per sec. is (1.3×10^{-12}) (600) $(300^4 - 283^4)$, or 1.32 calories.

Bringing the blood to the skin decreases the thickness of tissue between it and the surface, thus increasing the loss of heat by conduction (providing the temperature of the air is less than that of the blood). The rate of conduction of heat through a layer of substance is inversely proportional to the thickness of the layer. It is also proportional to the difference of temperature between the two sides. Therefore, on a hot day the blood is brought near the surface, to increase the conduction of heat outward; while on a cold day it is kept mostly behind a thick external layer, to decrease the loss of heat by conduction.

Clothing reduces both radiation losses and conduction losses. Some heat is radiated to the cloth, where it is absorbed and only slowly conducted away. Heat losses by conduction are greatly reduced, the greater the thickness of cloth, the smaller the loss. The rate at which heat is conducted away may be found by use of the equation,

$$Q = C A (l/d) (T_1 - T_2) t,$$

where Q is heat lost; A, area of surface; T_1 and T_2, temperatures of skin and outside air, respectively; t, time; d, thickness of cloth; C, a constant which varies with the kind of cloth. The following approximate values for C may be used, when Q is in calories, A in sq. cm., T in degrees C., t in sec., and d in cm.: smooth cotton cloth and cambric, 8×10^{-5}; woolens, silk, flannel and cashmere wool, 7×10^{-5}. The values vary greatly

with closeness of weave, so that if problems are made up for a class, other values (particularly higher ones) can be used.

OTHER APPLICATIONS OF PHYSICS TO BIOLOGY

These discussions cover but a few of the many important applications of the principles of physics which are built into the infinitely varied structures and activities of the biological world. Many other applications will occur to the teacher who wishes to enrich either physics or biology by tracing their interrelations. To teach biology without reference to any of the physics it involves is no more satisfactory than to teach it without reference to its chemistry. On the other hand, to teach physics without reference to any of its biological applications is to neglect a fruitful source of interest and to fail to lead the student to a broad understanding and appreciation of the unity of all science.

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Biology in Japanese Schools

(Continued from Page 36)

the hat was the broad brimmed sailor. It was entertaining to watch the groups walking along side by side, those in the wooden shoes making just as rapid progress as those in European shoes.

The trip to Chuzenzi is up a mountain road with thirty-six curves, most of which is so narrow that the traffic is patrolled. For two hours the cars go only up the road and for two hours they go only down, so that it is necessary to time one's arrival by car according to the patrols. This was difficult to do with crowds on foot and boys constantly jumping on the running boards of cars to get a lift for themselves. The narrow road stops at the falls, and from there on a broad winding road leads to Yumoto, the town on the top of the hill. Many of the students stopped at the falls where one of the best views can be seen, but there were still large numbers climbing on to the top. We rode to the top and walked down so as to get the full benefit of the many panoramic views which meet the eye at every turn of the road. We found many of the students who spoke encugh English to give us considerable information about these school trips which are financed by the government.

The maple trees were at their best that day. Like all Japanese growth they are dwarfed and more spreading than the maples in this country, and the leaves are so small and so delicately dissected at their margins that the general effect of their bright scarlet against the greens of the trees about them was one of lacy delicacy. It was like looking through a screen of scarlet lace to the mountain side. The trees have been planted intentionally to provide the most spectacular views, and have been so arranged with groups of cherries that the same road provides equally entrancing views in the spring when the cherries are in bloom.

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It has become somewhat of a national event for us when the cherry trees are in bloom in Washington in the spring, and many schools go by bus to take in the view; but I know of no case in America in which entire schools close for a day to send their pupils to enjoy the scenic beauty of their country. It was this appreciation of the beauty spots of Japan which impressed me most during my visit, and it seemed to me that a people so appreciative of beauty could hardly be as wholeheartedly militaristic as we are sometimes led to believe.

We are justly proud of our American schools, but there is certainly much that we biologists might learn from the little country across the Pacific. Science teachers are becoming more and more aware of the inadequacy of teaching within the confines of a school or college laboratory. In biology, especially, is it true that no real understanding of the laws which govern living things will penetrate to the minds of the students through the exclusive study of dead and pickled specimens.

The majority of teachers are making every effort to bring the living forms into the laboratory, and to have aquaria and herbaria of various types where the students can observe the living plants and animals. Some schools foster trips into the woods also, but very few schools are fortunate enough to have a natural laboratory within easy reaching distance, and still rarer is the school which has access to a marine aquarium or a marine collecting ground. Since many of the most typical and most primitive forms are marine, the importance of observing these specimens alive cannot be too greatly emphasized. To watch the colonial hydroids and the sea anemones expanding in translucent beauty is to put new life into a laboratory study, and to watch the slow progress of a starfish across the glass walls of an aquarium is to make more certain an understanding of its water vascular system.

Fortunately the supply houses are making every effort to meet this need and living forms can be transported to the inland laboratories today during the colder months of the year with a minimum of risk. Keeping the marine forms alive, however, is a task of greater proportions since it means the constant attention of the instructor. The sea water must be sent ahead and allowed to settle before the animals can be placed in it and aerating motors must be used constantly to keep the oxygen content up as there is no possibility of balancing an aquarium of this type in the short time it can be kept. Some seaweeds always accompany the animals, but these do not accomplish the necessary aeration. Moreover, the water must be removed and filtered frequently and any dead animals removed daily, if success is to be assured.

If these rules are followed, however, we have found in our laboratories that the animals can be kept for three or four weeks in cold weather. Nereis very quickly succumbs and must be observed as soon as possible, and starfishes are difficult to adjust. If they can be kept alive for a few days, however, they seem to adapt themselves and become quite vigorous. Fiddler and hermit crabs are popular with the students, and the hermits can be made to perform if two of them are removed from their shells and placed in a dish with only one empty shell available. Much entertainment can be derived from the ensuing struggle since two vigorous crabs will fight valiantly to obtain covering for their sensitive abdomens. The sea anemones can be fed with bits of clam meat to demonstrate their activities.

In the east, these aquaria can be obtained from the Supply House at Woods Hole, Massachusetts, and in the midwest from the Turtox Biological Supply House in Chicago.

We have many marine laboratories in America and these are utilized during the summer months by both students and investigators; but the number of students who enjoy their advantages is limited. It seems a pity that the buildings at Woods Hole, Cold Spring Harbor and Friday Harbor, where the collecting is so remarkable and the facilities for study so excellent, should not be available to students during the spring and fall months. Now that bus service has been so perfected that groups of any size can be transported to almost any spot in America, it would seem that ambitious biology classes might reach some such marine laboratory without too much time and effort. We sometimes send excursions of students to Virginia to see the caves at Luray. Why not send them to the seashore to enjoy a few days of collecting and observing the primitive animals and plants at home?

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Genetic Experiments

(Continued from Page 34)

that the etherizing bottle is now towards the light. A little shaking will help all the flies over, and the etherizing cork again is put in the bottle. When the flies become immobile, they may be examined either with a hand lens or a dissecting microscope. If the flies are to be used for mating, care must be taken that too much ether is not administered. When once the wings fold up, the flies are dead.

Distinction Between the Sexes

As a rule the males are smaller than the females. In the male the posterior of the abdomen is rounded, and the last two segments are black when viewed from the dorsal side. In the female the abdomen is broader, but the posterior is more pointed and banded with black, instead of being solid black as in the male. The males have sex combs, black bristles, on the tarsi of the first pair of legs. These are absent from the females.

Mating

For mating, virgin females are required. Experiments have shown that no mating occurs until the flies are at least eight hours old. This is a safe time, but more recent experiments have shown that even at fourteen hours no matings occurred. The first step is to remove all flies from the stock bottle. If the bottle is slightly moist a small amount of cornmeal can be shaken into it. This prevents the flies from sticking to the sides or bottom. Be sure that all flies are removed. The bottle is then set aside for the young flies to emerge from the cocoons. Provided the bottle has been completely emptied, within eight hours all the young flies will be unmated. These are then etherized and the virgin females selected and put into a new culture bottle. There is no need of selecting unmated males.

Crosses

For beginners, it is best to select characters which can be identified readily, such as sepia eyes, brown eyes, vestigial wings or black body. Select virgin females from any of these stocks and mate with the wild type male. Some prefer to put only one female with one male in a bottle, and if this is done small vials are preferable to large bottles as there is not so much chance for molds to develop. Results, however, will not vary if more parents are used, and larger bottles may then be employed.

These parents are allowed to remain in the bottle until the larvae begin to form cocoons. They may then be transferred to another bottle if more F_1 are desired. This procedure prevents the possibility of getting the parents mixed with the first generation flies. When the F_1 hatch, they should be examined for the characters involved and then transferred to a new culture bottle. If large numbers of F_2 are desired, the first generation flies should be transferred to new bottles every two or three days. There is no need that these F_1 flies be selected for virgins to obtain a second generation.

To obtain the back-cross ratio it is necessary to get virgins either from the F_1 or from the recessive mutant involved. The former are mated with the recessive mutant male, the latter with first generation heterozygous male.

When a two factor cross is desired, care must be taken that the mutants involved are located on different chromosomes. Two good characters are sepia and vestigial. A sepia-eyed fly with normal long wings may be mated with the normal red-eyed fly with vestigial or short wings. The double recessive sepia vestigial may also be mated with the normal wild red long. Good characters to show sex-linked inheritance are either white eyes or yellow body.

Since mutants are frequently less viable than the normal wild type, the ratios do not approximate the expected 3:1 as closely as desired unless all the second generation flies are permitted to emerge. The mutants usually develop at a somewhat slower rate than the wild type. Count all flies that emerge within ten days after the first flies emerge from the bottle. After that time there is the possibility that a new generation, an F_2, has developed.

Those who feel that they do not have the facilities to culture Drosophila would do well to obtain other materials to demonstrate the ratios in the second gen-

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eration. Excellent material is corn, and these F_2 ears can be obtained quite cheaply. Many characters are available, and these can be distinguished readily. It is advisable to leave the grains on the ear to show the chance combinations. Separate counts of each row will show how much variation occurs in the ratio when small groups are taken. Since there is a tendency for the grains to fall off the ear, especially with repeated handling, a method has been devised to avoid this. Dilute white shellac with about an equal part of alcohol, and let the ear soak in this mixture for a few minutes. Then put aside to dry. The grains will then be firmly held in the ear.

As a rule, students seem to understand quite well when crosses are explained on the board. These seem so simple that the students do not pay close attention to what has been done. When such problems are included in an examination, the difficulties appear. Quiz-sheets with blocks for the somatic and germ cells for both parents, and the F_1 used in conjunction with laboratory work, will help to make the chapter on genetics clear and interesting.

◆

Science in the Laundry

(Continued from Page 51)

but experiments discovered that by scientifically proportioning ingredients, a better grade of soap could be prepared commercially. Furthermore, the chemist converted inferior grades of fat into fatty acids of the highest grades of purity, an important factor in the detergent action of the soap.

The cleansing action of soap depends on the fact that it can emulsify grease and adsorb dirt particles. Soap, when dissolved in water forms a colloidal solution. The soap solution when agitated or rubbed with grease forms an emulsion with the grease. The dirt particles freed from the cloth adhere to the soap and are carried away with the wash water. Sometimes, however, detergents like soap do not restore the original whiteness of cloth. The cloth is immersed in bluing to counteract this tendency of white cloth to turn yellow. The best of these blues is aniline, not only because it is the cheapest and most effective, but also because it is so soluble and strong that only a small quantity is necessary to give a clear white color to the clothes. Blue is but slightly affected by strong alkalies and, since it does not contain iron, will not produce rust spots.

Sometimes bluing is insufficient and bleaching must be resorted to. The best method of bleaching is the natural one of placing wet clothes in sunlight, for bleaching is the chemical process in which color is removed by oxidation. In this natural process it is believed that minute quantities of ozone form to cause the bleaching. Some large laundry plants use hydrogen peroxide, but the most commonly employed chemical is chlorine, usually in the form of bleaching powder. This may be used on cotton material only. Animal fibers, such as silk and wool, must be bleached by special oxidizing agents, the former, by hydrosulphite of soda, the latter by sulphur dioxide.

In every industry there are exceptions which require special attention. This is also true in the laundry, for there are certain stained materials that require the attention of skilled workers. In such cases, mere contact with soap and water is not sufficient. The removal of the stain consists in taking oxygen from, or adding oxygen to, the stain, prior to laundering. These processes are known to the chemist as reduction and oxidation. The process of removing stains is really an industry in itself called dry-cleaning. Instead of ordinary soap and water, special dry-cleaning soaps are used in connection with benzol, naphtha, gasoline, etc. Such chemical solvents produce new compounds by uniting with the stain, and it is the newly formed compound which is really washed away.

Physics has contributed the principles of mechanics utilized in building laundry machinery and has also supplied the electrical power that operates the machines both in the household and in the commercial laundry. Modern wash machines are made of monel metal, an alloy of nickel, which retains its smooth surface because it is rust-proof and resistant to wear and corrosion.

The common type of washer consists of two cylindrical parts, one inside the other. The inner cylinder

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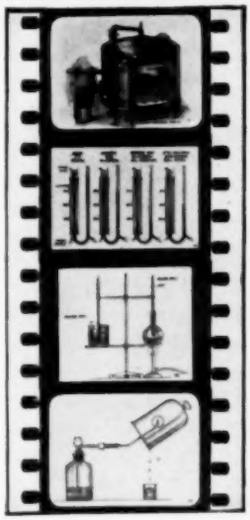

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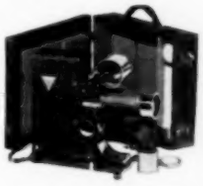

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is perforated and contains the soiled clothes; the outer contains the soap and water. As the two rotate about each other, the soapy water is forced through the soiled clothes and the dirt is washed away. When the clothing is completely cleansed, it is placed in the extractor, where centrifugal force expels the water and leaves the material almost dry.

The electric mangle, the electric iron, the two-burner hotplate for speedy and convenient preparation of starch, are devices that facilitate the tedious back-breaking ironing of former days. Seated comfortably before the mangle, with its thermostatically controlled temperature, employing no operation but a push of the lever and the directing of the clothes between the rolls of the revolving cylinder, saves time and labor for the operator. It produces a finished product that is a delight to the housekeeper. The electric irons, in varying sizes and weights, all with automatic heat controls are a real boon to the launderer today.

From the foregoing it will be seen how laundering has developed from its first crude stages and how man's inventions and discoveries have built up a thriving industry. But advancement in this field has not stopped. Wherever there are men who are eager to delve into hidden mysteries, there physical and chemical research will be made and will further the progress of man. And so laundering, directed by biology, chemistry and physics, will travel ever onward along the road that aims at speedy, efficient and simple methods of cleansing clothes.

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The Junior Academy

(Continued from Page 40)

whether the state junior academy of science is the proper organization for our Catholic high school science students. It may be objected first, that we are not wanted. The writer does not believe that there is any evidence for this. The contrary is true. If there were any adverse feeling, it certainly should appear in the state academy of which the writer is at present the head. But when the Alabama Academy of Science voted to establish a junior academy, the writer was placed on the committee appointed for this purpose, and organized chapters in four Catholic high schools in the state. These were welcomed with open arms, and, at the very first meeting in which they took part, three of the four officers of the junior academy were selected from these schools. Moreover, at almost every meeting one or more Catholic schools win prizes for the best paper or exhibit.

Secondly, it may be thought that our students might receive harm by belonging to an organization made up principally of public high schools, and their faith might be undermined by the theories propounded in the meetings. On the contrary, the writer believes (and this is also verified by our experience in Alabama) that by participating in the work of the junior academy of science our students can do much toward breaking down any bigotry that may exist, and toward raising the spiritual tone of the meetings. Last year our academy met at the state university. Besides students from three of the Catholic schools before mentioned (the fourth had closed in the meantime), some of the Sisters teaching in one of the schools also attended. This made a very favorable impression on both junior and senior academy members. The dean of women of the university with whom the Sisters stayed told me afterwards that she was charmed with them. One of the officers of the senior academy who is a professor in a state institution told me that from what he had observed of the scholarship and behavior of the representatives of the Catholic schools he had decided to have his daughter educated in one of them.

There are some who apparently favor a strictly Catholic organization, and in some parts of the country so-called "local branches" of the Catholic Round Table of Science have been started. At the Indianapolis meeting of the Catholic Round Table last Christmas, it was the opinion of the founders and many of the members of this group that such "local branches" are a misnomer, and not according to the original idea of the Round Table. Strictly speaking, the Catholic Round Table of Science is not an organization at all. It has neither constitution nor officers. It is simply a gathering of the Catholic scientists attending the meeting of the American Association for the Advancement of Science. The purpose is to get acquainted and to discuss the peculiar problems of the Catholic scientist, especially that of getting more Catholics to take an active interest in science, particularly of the productive type. Therefore, there can be no such thing as a "local branch" of a non-existent organization.

While it is a good thing for Catholic students of science to get together once in awhile, just as it is for their teachers, the writer believes that it is more important for them to become affiliated with their state junior academy of science and thus to get together with all the science students of the state. By so doing they will avoid narrowness on the one hand by seeing what students in the other schools are doing and, on the other, they will be able to exert a good influence on their non-Catholic confreres in the academy. They will also become entitled to share in the benefits derived by the members of the junior academy from their relationship with the senior academy. These include the advice and direction in their work by trained scientists, lectures from outstanding scientists, and in some cases, financial assistance.

Some years ago the question of the junior academy was brought before the Academy Conference of the A. A. A. S., especially in reference to the sponsoring by the latter body of a national publication for junior academies. At the St. Louis convention in 1935, Mr.

Watson Davis, Director of Science Service, which publishes the *Science News Letter*, proposed for appraisal and discussion by the Academy Conference a plan whereby this journal would "include eight times a year a special science club or junior science section of four pages, containing suggestions for club programs, material for discussion, etc. These special sections, which might be called *Science News Letter, Jr.*, could then be reprinted, forming a magazine that could be placed economically in the hands of every junior scientist."

Due to financial and other difficulties no action has yet been taken on this plan by the Academy Conference, but it will undoubtedly come up again. The writer believes that eventually the A. A. A. S. will take a more active interest in the junior academy movement. When it does, the high school science clubs that are members of the state junior academy of science will stand to benefit greatly by this relationship with the national science association.

At the same St. Louis convention, and also at subsequent meetings in Atlantic City and Indianapolis, the A. A. A. S. has sponsored participation in the national meeting by junior academy groups, and has secured for them time on the radio programs which have become a regular feature of these meetings.

In conclusion, the writer believes that one of the ways by which the dearth of Catholic scientists in the United States can be remedied is to form active science clubs in all our Catholic high schools, and to affiliate these clubs with the state junior academies of science so that our Catholic boys and girls will be brought into contact with the outstanding scientists of the state, and into competition with the science students of non-Catholic schools. As our experience in Alabama has shown, this competition will prove them to be not only the equals of the non-Catholic schools in scientific endeavor but even their superiors, thus affording another argument in favor of our Catholic system of education.

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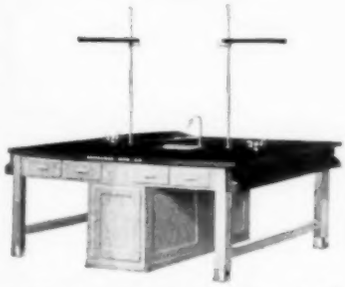

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Sugar from Sugar Cane

(Continued from Page 42)

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The water-white liquid from the char-filters is treated in much the same manner as is the purified juice of the raw-sugar factory. It is evaporated in the multiple-effect evaporators, and then in the vacuum-pans. The sugar is washed in centrifugals and is dried by a stream of warm air circulating in a special drier, the granulator. The sugar is passed over a set of screens where the crystals are separated, according to size, and sent to packing-bins.

The Chemist's Job

Chemical control was introduced into the sugar industry in the latter part of the 19th Century. The employing of trained sugar-chemists has been most advantageous to the owners of the plants, for these scientists have developed new methods which have reduced the loss of sucrose in the various processes.

The duties of the chemist are many and varied. Space does not permit of a lengthy discussion of the daily reports, the many calculations, the control tests and other analyses needed in the extraction of the sugar from the juice of the cane and the purification of the sucrose. A few of the more important tests on the cane, the juice, and the sugar, together with brief procedures for some of these, follow.

The Cane

The yield of sucrose depends upon the per cent of sucrose in the cane. The juice is extracted from a weighed sample of the substance and the weight of sucrose in the juice and in the bagasse is determined. With this knowledge the analyst computes the per cent of sucrose in the cane.

The Juice

The most important analyses on this substance are the density (specific gravity), sucrose content, true sucrose, reducing sugars, and the acidity.

The density is usually determined by means of hydrometers or spindles graduated in "degrees Brix." This degree is the per cent by weight of pure sucrose in a pure sucrose solution. It is customary to regard the degrees Brix as the total solids in solution. The pyknometer and Westphal balance are sometimes used in densimetric determinations.

In finding the sucrose content of juices, sugars, etc., the polariscope is almost indispensable. Sucrose, like many other substances, rotates the plane of polarization of light. Advantage is taken of this fact in sugar analyses. The instrument most commonly used in the sugar industry has a Ventzke scale. This scale is so divided that, if a "normal weight" (26 g.) of the substance is dissolved in sufficient water to give a total volume of 100 ml. and polarized in a 200 mm. tube at 20° C., the reading is in per cent sucrose. A normal weight of the strained juice is clarified with a dilute solution of lead subacetate and the volume made up to 100 ml. with water. The mixture is filtered and the filtrate polarized. The polarization is the per cent sucrose.

True sucrose is determined by a double polarization method. The normal weight is clarified and polarized. This direct reading is the resultant of the polarization of sucrose, *d*-dextrose, and *l*-fructose. A second normal weight, after clarification, is inverted by means of hydrochloric acid. The sample is polarized at the same temperature as the first. This invert reading is due to

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the inversion of sucrose. From these observations the true sucrose content is computed.

The reducing sugars in the juice are determined either volumetrically, gravimetrically, or electrometrically. In the volumetric method a modified Fehling's solution is standardized against an invert sugar solution. A measured volume of the standard solution is titrated, while hot, with the prepared juice. The per cent reducing sugar is calculated from the volume of the juice required to effect complete reduction of Fehling's solution, the weight of juice per cc., and the grams of invert sugar equivalent to the volume of the reagent used.

The acidity is reported as the number of cc. of 0.1 N sodium hydroxide solution required to neutralize 10 cc. of juice using phenolphthalein as the indicator. The p^H is obtained by colorimetric or electrometric methods.

The Sugar

The polarization (sucrose content), true sucrose, reducing sugars, moisture, and ash are important determinations. The methods employed in determining the sucrose content, the true sucrose, and the reducing sugars are similar to those given under juice analysis.

REFERENCE

Spencer, G. L. and G. P. Meade. *A Handbook for Cane-Sugar Manufacturers and Their Chemists*, John Wiley and Sons, Inc.

Demonstrations in Teaching

(Continued from Page 50)

ture of money that was required to produce fairly attractive and instructive material for class demonstration and for the crystallization of facts picked up in reading, in causal observation, in the laboratory exercises, and in the various types of field trips that we have mentioned.

There is so much to be said about the methods of teaching in biology that I shall try to make one point only. I warn against the danger of introducing any subject in isolated units by hacking it into pieces. Life is possible only through the harmonious activity of complex systems resulting in mysterious operations which maintain that life and generate new individuals which perpetuate it. Therefore, in presenting any principle or process or phenomenon of life for study, while we must place the emphasis on some particular system or organ or phase, we should, as far as possible, present the picture as a whole. In case you wish to teach fruit structure, for example, try always to have on hand some of the flower buds and transition stages between the full blown flower, as a middle phase, and the unopened bud at one extreme with the incipient and fully developed fruits at the other. It is not difficult then to show seeds and the germinating seeds and seedlings, with the adult plant which will show root,

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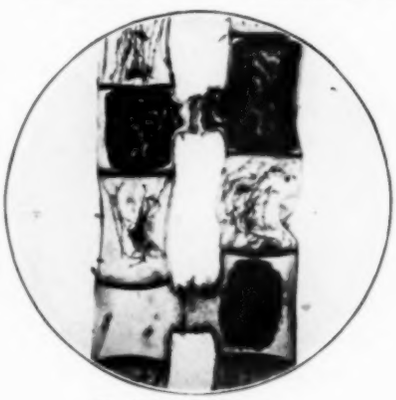

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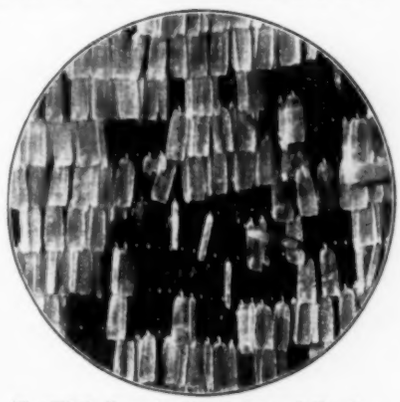

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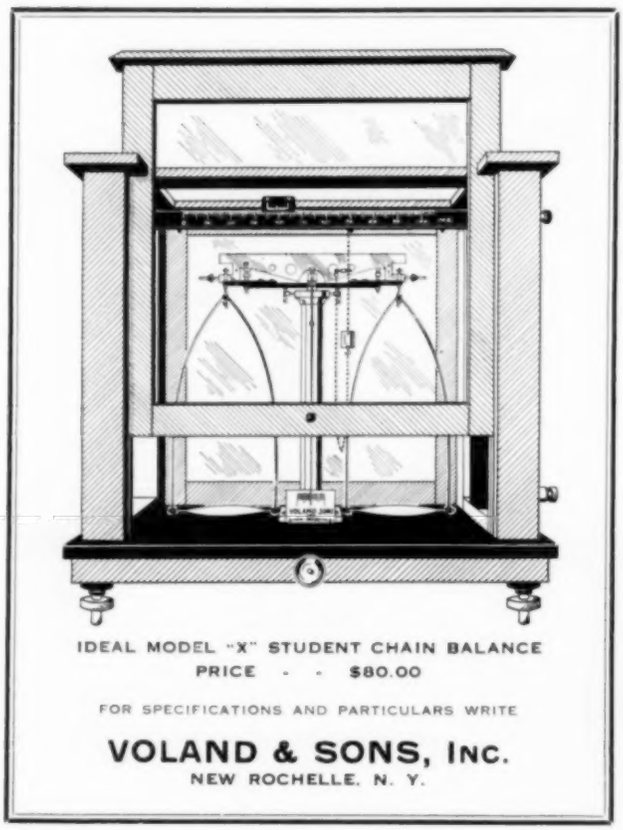
stem, leaf, flower and fruit. If your course is in the fall, the snapdragon which has large inflorescences with many stages of floral development in well graded transitions from the apex to the base of the flower cluster, will serve your purpose. The pupils can readily see what happens to the pistils of these flowers as the petals wither and fall. In the spring, the strawberry, the tulips and some of the wild flowers may be used. Some ripe seeds of these or some similar plants, if germinated at this time, will supply the missing steps in the complete life cycle. Good pictures or other illustrations may also be employed to fill in the gaps.

The same study can easily be done with garden peas and beans or their kin among the wild plants. Cucumber vines, also tomato plants will show simultaneously many stages of floral and fruit development. Wherever it is impossible to supply certain stages in living materials, these can be supplemented by dried or preserved specimens. However, it is not difficult to supply all phases of many organisms at the same time. Pumpkins and squashes are such quick and easy growers, that one can easily germinate the seeds and grow the plants to the blossoming stage indoors. It is a simple matter to supply a specimen of the ripe fruit and the developmental stages of the fruit are easy to visualize if the corresponding stages have been observed in other plants. The same principles apply to the life histories of animals such as insects, the frog or the chick.

These big entire pictures will mean more to the child, or to an adult who is an amateur in science, than too many details at the beginning. Details are tremendously important for the initiated and for the specialist, but for the great majority their importance is by no means proportionate to the generalities of knowledge. Let us, therefore, make a wise choice. We must not put ourselves and our students in the position in which they will be unable to see the forests for the trees.

And one more warning note at the risk of my being condemned as a heretic by many of the modern educationists and quasi-scientists; but I believe and I cannot insist upon it too emphatically, that too much activity under the name of science teaching, at the expense of real thinking, is most detrimental to progress in general knowledge as well as in science itself. I mean exactly that there is grave danger of over-stressing a kind of science teaching in the so-called activity program in our elementary schools. This feverish overwrought type of school program may, and I fear will,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in the end hinder more than help the potential scientist who, like every other truly educated individual, must be grounded in the fundamentals, by which I mean mathematics, the classics, logic, yes, and rhetoric. These are merely the essential disciplines and the indispensable groundwork for any superstructure which may bear the dignified name of culture. After all, our function as classroom teachers is to try to develop thinkers rather than artisans, mechanics, craftsmen, technicians, or even scientists! It is far more important that our future citizens be stimulated to think and to think for themselves than to, first of all, become dexterous in the use of scientific apparatus, or any other kind of physical activity.

We believe, then, that our foremost duty as teachers and particularly as teachers of the natural sciences, is to train not so much for doing as for thinking. Any stimulation for which we are responsible is worthy only according to the amount of right thinking that it provokes. We are not overseers or foremen but we should endeavor by word and example to be real agents which stimulate genuine cerebral activity. If we succeed in this, our efforts will be fruitful in developing in our charges the power and the courage to act when and in the manner that is best.

And, finally, let us as those who are privileged to be teachers, and Catholic teachers of Catholic youth, beware of the forfeiture of our noble heritage. We should always welcome, foster and encourage all that is good in the greater development and progress in the natural sciences and in whatever else that is worthy of a place in our lofty vocation. We may hope best to accomplish these ends, however, by holding fast to our matchless traditions and by ever remembering that ours is the only true philosophy, the genuine art, and that we are the exclusive possessors of the greatest of all sciences, Theology, The Science of God.

◆

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Researches at Institutum Divi Thomae

Subjects as diverse as wound-healing and fruit-fly eye color are discussed in a new issue of "Studies of the Institutum Divi Thomae," science journal of the post-graduate scientific research unit of the Athenaeum of Ohio, at Cincinnati.

Working on the theory that living cells, the building bricks of all living things, live together in a community life which is regulated by hormone-like substances which they secrete, Dr. Robert J. Norris and his associate Cornelius Kreke have been able to demonstrate that various plant and animal cells secrete three kinds of materials which control cell activity. One group of substances controls cell breathing (or respiration), one controls the multiplication of the community (or proliferation), and a third controls the utilization of sugars as food sources for the cells. The isolation of these controlling factors casts new light on what happens when human tissues fail to function normally in various diseases.

By injuring yeast cells with ultra-violet light, Dr. George Sperti, Director of the Institutum, Dr. John R. Loofbourow, and Sister Cecelia Marie Dwyer, S.C., were able to show that the injured cells secrete materials which stimulate normal surrounding cells to grow and multiply. They report that this action takes place for animal cells as well as for plant cells, and suggest that it is the fundamental mechanism of wound healing.

New light is shed on the problem of how hereditary traits are transmitted in a report by Professor John C. Fardon and Sister Mary Jordan Carroll, O.P., in which methods of physics involving an instrument called a "microspectograph" have been applied to the study of the transmission of eye color from generation to generation in fruit flies. It has been thought that the controlling factors for all hereditary traits are bottled up in tiny thread-like substances, the chromosomes, and chromosome maps have actually been drawn in which positions were assigned to each hereditary characteristic. The findings of the Institutum workers indicate that the problem is considerably more complex than it has hitherto been thought to be, and that the simple choromosome explanation will not suffice.

Professor Agnes Helmer and Father Cornelius Jansen report investigations showing that the vitamin D contained in the oils of the skin is washed off in bathing. This vitamin is formed in skin oils by the action of sunlight, and those who are fortunate enough to be able to sun themselves on bathing beaches have an adequate supply of it. Under crowded conditions in dark cities, however, limited exposure to sun results in a deficiency of the vitamin. The new findings of the Institutum researchers indicate that this deficiency is accentuated by loss of the vitamin in washing.

How plants are able to utilize the sun's energy in building up foodstuffs which support animal life has been a great mystery of science. Dr. William A. Beck, S.M., attacks the problem from a new angle. Studying the effect of light and pressure on the development of plant pigments, known to be concerned in the plant's utilization of sun energy, Dr. Beck has found that high-pressures definitely stimulate the production of plant pigments. In collaboration with Father Richard Redman and Sister Mary Petronella Schroeder, C.PP. S., he reports that the formation of the green coloring matter, chlorophyll, in plants is directly proportional to the time of exposure to light. These investigations open the door to a better understanding of the relative importance of the different plant pigments in converting the sun's energy into useful forms.

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Atom Smashing Machine

A model cyclotron to smash atoms, which is being built by the University of California to be exhibited at the 1939 Golden Gate International Exposition, promises to be one of the outstanding scientific sensations of the $50,000,000 World's Fair of the West.

Present plans call for the cyclotron, which consists principally of two huge magnets, to be surrounded by a glass tank 35 feet in diameter. Through this glass the public may view its operations.

This cyclotron will occupy a prominent space in the Hall of Science at the Exposition, but University officials will augment that display with others on chemistry, astronomy, mathematics, medicine, botany, biology, oceanography and paleontology. The University exhibit will occupy one-third of the floor space in the science hall.

In the other exhibits, interesting phases of human heredity, development of plant and animal life, microscopic views of the sea floor and man's development of the sciences will be portrayed.

◆

Spanish Moss Not Spanish

Its name is the only Spanish property of Spanish moss. Like many other things in nature it was inadvertently named, without reference to science. Perhaps it was logical that the graceful plant should have been called Spanish moss since the Spaniards were the first from the Old World to make its acquaintance.

Spanish moss is not a parasite, but an air plant familiar to all who have visited the Southern States where it festoons the branches of living trees. It will not grow on dead trees, though for years it will hang from them, dead itself, until the winds and storms have destroyed its wraith-like form.

In the proposed Everglades National Park, Florida, acres of live oaks are draped with Spanish moss.

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